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Putting Life Into Science

• By Frank B. Lindsay, M.A. *(Claremont Colleges)*
ASSISTANT SUPERINTENDENT OF PUBLIC INSTRUCTION, STATE OF CALIFORNIA;
CHIEF, DIVISION OF SECONDARY EDUCATION, SACRAMENTO, CALIFORNIA

This interesting article is a report of a cooperative study made by 15 California high schools under the direction of the State Department of Education. It sought to determine if instruction could be improved significantly through the liberal use of current magazines and audio-visual aids in the regular science courses.

Teachers as well as pupils profited by the study. Teachers learned the necessity for long range planning and for care in selecting and presenting the new materials. Pupils responded well; even the slower ones were stimulated. Parents became interested, and a fine spirit of cooperation between school and home resulted.

In the autumn of 1945 the Division of Secondary Education, California State Department of Education, approached fifteen high schools located in urban and rural communities to enlist their cooperation in a study of the improvement of instruction through the liberal use of current magazines and audio-visual materials in regular courses of study. It was believed that since learning occurs only when students individually achieve genuine personal experiences from their contact with subject-matter, the more that the information of textbooks can be related to their lives and concerns the better will be their achievement in studies. It was also the conviction of the sponsors of the study that the likelihood of learning taking place would be enhanced by multiplied presentations of the principles of science in action, for example, as reported in films and magazines, to reinforce textbooks and laboratory demonstrations. This also seemed consistent with the data on individual differences, for some students learn more readily through their reception of visual and audial imagery than by printed matter alone. Finally, it was hoped that familiarization with sources of information by which adults commonly acquire data for opinions, at a time when critical evaluation of these might be encouraged, would assist them in their future performance as citizens.

Although the cooperative study embarked upon by the fifteen high schools included classes in English and United States history and civics, the present report will attempt to summarize only the findings of teachers of science. It must be borne in mind also that limitations of materials prevented their ultilization during this pilot study in more than a few classes within any school. It needs likewise to be known that each teacher participating in the project volunteered because of personal inter-

THE SCIENCE STUDY

High School	Grades in high school	Pupils in high school	Number of Class sections in Study	Number of Pupils	Science Class Instructor
			Biology		
Bakersfield	9-12	4,000	3	90	Axel L. Petersen
Pittsburg	10-12	500	2	50	Mrs. Helen M. Smeltzer
Sequoia, in Redwood City	9-12	2,000	2	62	Mrs. Anna L. Bigler
			Chemistry		
Delano	9-12	750	2	40	C. J. Roupe
Fortuna	9-12	500	1	25	Stephan D. Coleman*
Kearny, in San Diego	7-12	1,200	1	30	Miles M. Miller
La Jolla, in San Diego	7-12	900	2	55	Earl K. Outcalt
San Dieguito, in Encinitas	7-12	550	1	28	Mrs. Charmion B. McMillan
Santa Paula	9-12	700	2	38	Henry J. Hill
			Physics		
Corona	10-12	400	1	15	Charles J. Slattery
Fortuna	9-12	500	1	21	Stephan D. Coleman*
Kearny, in San Diego	7-12	1,200	1	20	Miles M. Miller
Lincoln, in San Jose	9-12	750	2	49	Harold E. Fisher
			Physical Science		
Point Loma, in San Diego	10-12	1,000	1	23	Donald R. McKenney

*Deceased

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Criminalistics

• By Ralph F. Turner
DEPARTMENT OF POLICE ADMINISTRATION, MICHIGAN STATE COLLEGE, EAST LANSING, MICHIGAN

The author of this brief article is a graduate of the University of Wisconsin, later spending two and one-half years in the University's Crime Detection Laboratory. For a number of years he supervised the laboratory of the Police Department of Kansas City, Mo. He is associate editor of the "American Journal of Police Science."

Here he gives a brief account of the kind of work done every day by men engaged in scientific criminal investigations.

The term criminalistics may be new to readers of *The Science Counselor*, and the author welcomes this opportunity to acquaint its readers, and educators generally, with this relatively obscure word. At first glance our title may appear pseudo-scientific or meaningless; yet in its use the writer reflects, in part, the views of Prof. Paul L. Kirk of the University of California, expressed in an article on criminological nomenclature.[1] Criminalistics is used occasionally in Europe to designate the sciences of laboratory crime investigation. We consider this word more appropriate than police science, forensic science, criminology and similar terms. Its adoption will help standardize criminological nomenclature.

History

Current scientific criminal investigation represents a conglomeration of laboratory skills that are utilized in the technical bureaus of police departments. Each year sees new scientific procedures being utilized by the criminalist but, unfortunately, the separate techniques are usually not adopted by police workers at the same time.

The very exact science of personal identification by comparison of fingerprints was an outgrowth of the *portrait parle* method of description devised by Alphonse Bertillon in the latter part of the 19th century.

The first fingerprint used for identification is credited to the Chinese about the 3rd Century B.C. There is a record of a fingerprint on a Chinese deed of sale in 1839. Scientific investigation of fingerprints from anthropological and physiological standpoints dates back to the time of Malpighi in 1686. Modern identification of fingerprints is credited to Sir William Herschel and Dr. Henry F. Faulds. Other workers who followed in rapid succession were Galton, Henry, Vucetich and Wilder.

In 1904, the United States Government authorized the fingerprinting of prisoners in the Federal Penitentiary at Leavenworth, Kansas. In 1896, the International Association of Chiefs of Police started a collection of fingerprints which were pooled in one file in Chicago. The two collections of fingerprints were merged in 1924 to form the Identification Division of the Federal Bureau of Investigation, which, at present, contains in excess of 105,000,000 cards.

Firearms identification, or the application of a study of internal ballistics to the examination and identification of guns, bullets and cartridge cases probably originated in New York State as a result of the work done during the trial of one Charles Stielow in 1915.[2] Added impetus came from the vigorous investigation which was the outgrowth of the gangland St. Valentine's Day Massacre in Chicago in 1929. The efforts of a group of civic minded individuals in that city bore fruit in the establishing of the Scientific Crime Detection Laboratory at Northwestern University.

Scientific examination of questioned documents in the United States owes much to the late Albert S. Osborn (1858-1946) who began practicing in 1910. He is the author of several texts, all of which are standard reference works.*

In addition to these rather well known fields, the criminalist cannot but be aware of the significance of the contributions of the late Dr. Landsteiner, and of Weiner[3] and Boyd[4] in he field of serology and immunology; the tremendous advances made in the utilization of new photographic technics and equipment in recording and solving police problems; the utilization of new analytical procedures in the realm of chemistry; the excellent work in toxicology being performed by A. O. Gettler[5] and C. W. Muehlberger;[6] the vitally important alcohol studies conducted by Harger,[7] Forrester,[8] Jetter;[9] and the invaluable aid rendered by medico-legal experts such as Gonzales,[10] Vance,[11] Helpern,[12] Moritz,[13] Snyder,[14] *et al*, in the solution of difficult cases involving sudden death.

The detection of deception by examination with the polygraph is rapidly being developed into a rather reliable science which is being used in criminal and civil investigations.

Probably the most widely known scientific crime detection laboratory in the United States was established in Washington by the F.B.I. on September 1, 1932.

Routine Work

In an article of this length it is impossible to describe in detail the application of various sciences to the solution of crime. Therefore, typical cases will be described in an effort to show how the various scientific aids are used.

*Osborn, A. S., *Questioned Documents, The Problem of Proof, The Mind of the Juror, Questioned Document Problems.* Boyd Printing Co., Albany, New York.

COMPARISON MICROSCOPE AND CAMERA. Used to examine and compare rifling marks on fired bullets.

Fingerprints. Latent (invisible) fingerprints may be developed on a piece of paper by the application of 3—5% silver nitrate solution. It is assumed that a burglar may have handled the paper during the course of the crime. The latent prints are compared with known fingerprints in the criminal identification file, and a possible identification of the criminal may be effected.

Firearms. A fatal bullet is removed from the body of a victim of a homicidal shooting. A suspect is apprehended and a handgun of the same caliber as the fatal bullet is found in his possession. A bullet shot from the suspect's gun and the fatal bullet are examined with the comparison microscope to discover if both bullets were fired from the same gun.

Documents. A series of fraudulent checks is brought to the attention of a document examiner. With these are submitted authentic samples of a suspect's handwriting. The document examiner can determine whether or not all the documents were executed by the same individual.

Serology. A car, suspected of having been involved in a fatal hit and run accident is being examined by police officers. Red-brown or black stains are noted on the front fender. The alibi of the driver is that "I ran over a dog on the highway." If there is a sufficient amount of sample in the proper state of preservation, the serologist may determine:

1. If the stain is blood.
2. If it is human or animal blood.
3. If animal blood, if it is dog blood. (For this particular case.)
4. If it is human blood, to what group it belongs.

Photography. It is believed that a portion of the ink writing on a document has been chemically eradicated. The document is illuminated (in the dark) with ultraviolet light, and a photograph taken. The eradicated writing may be thus restored.

Toxicology. Some time after burial, the question of arsenic poisoning may arise. The body of the supposed victim may be disinterred, and an analysis of vital organs or hair and fingernails made for accumulated arsenic.

Alcohol Study. In the not far distant past, the mere odor of alcohol on the breath was sufficient evidence to convict a driver of operating a motor vehicle under the influence of an intoxicating beverage. Today, analysis of the breath, saliva, blood, urine and spinal fluid to determine the actual alcohol concentration, coupled with a scientific interpretation of the findings enables the court to render a more just decision.

Legal Medicine. A complete autopsy of a body involved in a case of sudden or violent death may answer some of the following questions:

1. Did the victim die of drowning in salt water or from other causes? (A determination of the sodium chloride content of the heart blood from the left and right ventricles may help to clarify the problem.)
2. What type of weapon may have been used to inflict certain injuries?
3. Was the body a victim of auto trauma or death from some other cause?
4. What was the approximate time of death?
5. Is there evidence of rape?

Lie Detection. The proprietor of a small business claims he has been the victim of a hold-up. There is reason to doubt this story. An interrogation with the aid of the polygraph establishes that the business man simulated a hold-up to conceal certain losses.

Thus, without any undue stretch of the imagination one can begin to see the value of the trained scientist in a modern law enforcement agency.

Academic Interest in the Problem

Police departments during the past two decades have received publicity (aside from routine performance of normal function) from two rather widely separated sources. One has been the exposé of sordid inefficiency, corruption, graft, etc., which has occurred at some time or other in virtually every section of the country to a greater or lesser degree. The other has been the rather recent interest in elevating the standard of police work to a plane on which it will enjoy the professional standing it justly deserves.

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Gardens are Science Projects

• By Paul R. Young, M.S. *(Cornell University)*
SUPERVISOR OF SCHOOL GARDENS, CLEVELAND PUBLIC SCHOOLS, CLEVELAND, OHIO

For forty years the Cleveland school system has maintained a garden-science program that has benefited the pupils, the schools, and the community. Last year, 8500 pupils planted gardens, 1200 in school garden tracts, the others at home.

The course of study begins with simple gardening units taught to third grade pupils, and culminates in a three-year technical curriculum in horticulture.

In this paper, the experienced Supervisor of this highly developed instructional program discusses its purpose, its methods, and its values. We hope his account will encourage other school systems to experiment in the field.

In 1947, 8,500 elementary and junior high pupils in the Cleveland Public Schools grew gardens, at home or at school. These were planned gardens, garden projects, science projects. They were the result of science instruction, voluntarily undertaken and successfully carried through because of knowledge and interest gained in the science classroom.

As science projects they made science live, for the boys and girls who undertook them. They bridged the gap between real life and classroom science, which for so many children is a difficult achievement. They were truly "adventures in science", carried on with the true zest of the seeker after knowledge, for no pupil receives any school credit for gardening, in the Cleveland program.

As gardens they produced, at conservative estimates, food and flowers worth at least $50,000 to their parents. They afforded individually and socially profitable occupation for untold leisure hours. They taught many desirable traits of character in the most effective way, by practice. Best of all, they were fun.

The Cleveland Program

For more than forty years Cleveland's school system has recognized the place of gardening in the lives of the people and has provided a developing program of garden instruction and practice. Gardening is taught in the elementary and secondary schools as a part of science, and practiced as a voluntary activity which brings enjoyment as well as educational experiences to the pupils. It is thought of primarily as a hobby interest, but one which is valuable to the individual and which contributes much to community improvement. Gardening is considered as fundamentally a means of education in its broadest sense, providing contacts between many of the regular school subjects and an exceedingly important phase of human experience—the production of food and beauty from the soil.

Gardening is Taught

All Cleveland school pupils participate in the school gardening program. Special gardening units are a part of the science course of study from the third year through the ninth. Teaching outlines and materials for demonstration and practice are provided for each school by the Garden Division, set up as an Auxiliary Agency correlated with the science instruction program. These units in elementary grades deal with the planting and care of a small vegetable or flower garden. In junior high grades more of the underlying reasons are considered. Study topics include lawns, shrubs, trees, perennial flowers, and the uses of these plant materials around the home; soils and fertilizers; pest control materials and practices.

Pupils Grow Gardens

In early spring pupils in all grades from the third year up, are given an opportunity to enroll for practical gardening projects if they wish. While school garden tracts are available to the boys and girls of a few schools, most of them must do their gardening at home. Of the 8,500 enrolled in 1947, 7,300 were home gardeners and 1,200 had their plots in school garden tracts.

GETTING INSTRUCTIONS before the day's work in their gardens at Harvey Rice Garden, Cleveland Public Schools.

Whether carried on at home or at school the school-sponsored gardens are specific, with plans, seeds, plants, fertilizer, etc., furnished to the youngsters enrolling, in return for an enrollment fee which covers the actual cost of materials at wholesale rates. With supplies furnished by the Garden Division and placed in their hands through the science teachers who enroll them, and with planting and care taught through the garden-science lessons, pupils who garden at home are able to do a rather surprisingly good job of gardening. Student gardeners on the school tracts do their work under the direction of trained garden teachers, so their gardens set an even higher standard.

Supervision

School tract gardeners work under supervision at all times, of course, but the home gardeners must be visited by the teacher if they are to get any help on the job. Two home visits, by their own science teacher employed for the purpose if possible, are provided for each home gardener, one right after the close of school in June, the other just before school reopens in the fall. These home contacts by experienced teachers promote interest, enthusiasm, and good work by the boys and girls. Such visits to the homes also promote better understanding and cooperation between parents and teachers.

While help and encouragement for the youngsters are the primary purposes of the supervision, grades are given for the work done, and special certificates are awarded to those who do a satisfactory job. Of the 8,500 pupils who enrolled for garden projects in the spring of 1947, 71 per cent were awarded certificates. In view of the fact that the spring of 1947 was for gardeners the most discouraging and difficult on record, this figure speaks well for the enthusiasm of the boys and girls.

Land and Equipment

Plant and equipment for the school gardening program in Cleveland at present comprise a sizeable greenhouse and garden area at West Technical High School, a roof greenhouse at East Technical, a small greenhouse and workroom at Thomas Edison Occupational School, and from one-half to five acres of improved and equipped garden land at Benjamin Franklin, Harvey Rice, Henry W. Longfellow, Memorial, Miles, and Wade Park Schools. All except the last (one-half acre) are on Board of Education property. An aggregate area of about 16 acres is included in these garden centers, of which nine and one-half acres are used for children's individual plots, and the remainder for general instruction of pupils and the public.

At West Technical greenhouse and gardens a three-year technical course in horticulture is available to those attending that school and open to all Cleveland high school pupils. Here, also, is the production and distribution center for plants, seed collections, soil, fertilizer, demonstration and illustrative material, etc., furnished and delivered to all schools in the city, for the use of teachers and pupils. The valuable plant and equipment thus directly serve the whole school system.

A more general high school course in horticulture or gardening is given at East Technical High School, with pupils getting practical outdoor experience at Harvey Rice Garden, since no land is available for gardening at the East Tech building. The work at Thomas Edison Occupational School is more elementary, but with emphasis on practical work.

From all three of these centers young people are able to go directly into horticultural jobs, but whatever their final vocation, their practical garden training will make them better citizens and homemakers.

Staff

While the teaching staff for the Cleveland school gardening program includes most of the elementary and junior high science teachers of the city, teaching and management at the various garden tracts, and other specialized phases of the program, are in the hands of special teachers trained in horticulture. Six of these people are employed on a 12-month basis, two on a regular school-year basis. Four greenhouse and garden superintendents, civil service employees, provide the practical job-supervision needed for hourly laborers and student assistants, who round out the staff.

The use of older students as paid assistants for garden work not logically a part of the regular pupils' practice work, has been consciously developed in the

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TRACT GARDEN PLOTS are identical in plan, for effective group work in planting and for attractive appearance.

Girolamo Saccheri, S. J.—Non-Euclidean Geometer

• **By Robert B. Morrissey, M.S.** *(Massachusetts Institute of Technology)*
PROFESSOR OF PHYSICS, MANHATTANVILLE COLLEGE, NEW YORK, N. Y.

This brief article directs attention to a little known priest geometer of the early 18th Century.

The series of demonstrations he devised in a zealous attempt to prove the validity of Euclid's parallel postulate constituted the first non-Euclidean geometry.

A more extensive account of Saccheri's life and works, published by the author in another journal[1], furnished the material for this paper.

Historians of mathematics now acknowledge the *Euclides ab omni naevo vindicatus* by Girolamo Saccheri,[2] S.J., to be the first non-Euclidean geometry. Professors Mansion,[3] Bonola[4] and Coolidge[5] have each named non-Euclidean theorems in his honor, and Sir Thomas Heath[6] credits him with fully anticipating Mill in the latter's account of the distinction between *nominal* and *real* definitions. But recognition of Saccheri's work has been rather tardy—which is not uncommon in the history of science. His *Euclides* lay hidden until Father Manganotti, S.J.[7] accidentally discovered it. Then Beltrami[8] hailed Saccheri as the precursor of Lobachevsky and Bolyai, who are generally credited as the founders of non-Euclidean geometry. Even today Saccheri's life and works are practically unknown except to a small number of scholars, and there is no mention of this great priest geometer in *The Catholic Encyclopedia.*

Girolamo Saccheri was born in the town of San Remo, Italy, sometime during the night between the 4th and 5th of September, 1667. Very little is known about his early youth, but his religious life has been recorded by the well qualified Father Gambarana[9], S.J., his friend and associate for thirty-five years.

Young Saccheri entered the Society of Jesus on May 8, 1685, at Genoa where he spent two years in the novitiate and the next three teaching grammar in the College. He was then sent to study philosophy and theology at the Collegio di Brera in Milan where he came under the influence of Father Tommasso Ceva, S.J., a brother of the more famous mathematician, Giovanni Ceva, for whom Ceva's theorem was named. A Latin poet of note but better known by his works on mathematics and mechanics, Father Tommasso Ceva soon discerned Saccheri's remarkable aptitude for mathematics, and suggested that he make a study of the *Elements* of Euclid. Under Father Ceva's guidance, the young student made such rapid progress that within three years he had published his first book, *Quaesita geometrica*[10], a rather ingenious tract on geometry. Father Ceva sent a copy of the book to his friend, Vincent Viviani, hoping to win for his young protégé the interest of that illustrious mathematician, having already won that of his own brother Giovanni. Viviani sent his congratulations to Saccheri and a correspondence developed between them. The few of their letters now extant have been preserved for us by A. Favro[11], the editor and publisher.

Father Saccheri was ordained to the priesthood at Como in March, 1694, and then ordered to teach philosophy and polemic theology at the Collegio dei Gesuiti in Turin, where he remained until 1697. During these years of philosophic teaching, he wrote the *Logica demonstrativa*[12], a little book "whose superlative merit" says Giovanni Vailati[13], "gives him an eminent place in the history of logic."

Father Saccheri spent the next thirty-six years as a professor of mathematics at Pavia; first at the Collegio dei Gesuiti, from 1697 to 1709, and then at the University until he died. At Pavia Father Saccheri climaxed a brilliant and fruitful career with the publication of his famous *Euclides.*

Referring to Saccheri's *Euclides*, G. B. Halstead[14] states:

> "This book contains not merely 'another work on geometry', but another *geometry*, a thought so tremendous, so unorthodox, that its discovery in his book by these great Church Dignitaries would have doomed Saccheri to death. Perhaps an after suspicion of the truth did doom him to death, for the permission of the Provincial was given August 16, 1733, and Saccheri was dead October 20, 1733."

That this comment is gratuitous should be evident to anyone who has investigated the case. Indeed, A. F. Emch[15] considers Halstead's comment "fantastic, for there is no evidence that either Saccheri or the church dignitaries perceived 'another geometry', in the Euclides." But even on the contrary supposition, that Saccheri or the Church dignitaries did perceive "another geometry", the comment is still untenable. The reliable Father Bosmans, S.J.,[16] tells us that Saccheri was in the habit of spending vacations during the autumn in Milan. There he went in 1773, hoping to regain his health, which had been seriously broken for some time, and planning at the same time to go over the proofs of his *Euclides.* And from this last sojourn in Milan, God called him to his eternal rest.

With a strong predilection for logic, it is quite natural that in his long career as a professor of mathematics, Saccheri would show a preference for the geometry of Euclid. Nor is it surprising to find him attempting to prove Euclid's fifth, or parallel, postulate, a problem which some of the greatest mathematical minds—Ptolemy, Clavius, Wallis, Legendre, Laplace, Gauss and many others—have made noteworthy but unsuccessful attempts to solve. This postulate states that "if a

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Petroleum in the Life of the Nation

• **By W. A. Gruse, Ph.D.** *(University of Wisconsin)*
GULF RESEARCH & DEVELOPMENT COMPANY'S MULTIPLE FELLOWSHIP, MELLON INSTITUTE, PITTSBURGH, PENNSYLVANIA.

This is not a "scare" article", but it will cause sober thought.

Well informed persons are worried about America's dwindling petroleum reserves. At the present rate of consumption our known supplies will not supply our needs adequately very long. And the demand for liquid fuels and for other products of petroleum increases continually. What will the outcome be?

Dr. Gruse, a noted expert, considers the problem from several points of view, pointing out how much our nation now depends on petroleum, and how our life in the future may be affected by a scarcity of oil. He considers the possibilities of discovering new oil fields, of importing, and of converting natural gas, coal, and shale into liquid fuels.

Prior to the beginning of World War II, the function of petroleum in the national economy occupied little space in the public press and received little attention from the public mind. It was known that in World War I the Allies had sailed to victory on a tide of American petroleum; private industry supplied, promptly and at a low price, every demand for petroleum products; the price of gasoline decreased (though the gasoline tax increased) and the oil companies, under the lash of competition, offered almost daily new and more efficient commodities. It is true that at intervals some Cassandra or other would predict the exhaustion of our petroleum supplies, but the geologists, the geophysicists and the wildcatters always came up with new boom fields, and our total proved reserves of oil underground increased steadily.

This feeling of security began to fade during World War II. The open symptoms of the new complication were the rationing of gasoline and domestic fuel oil. The press carried notices of the tremendous volume of petroleum being furnished to our Allies, and there was some public discussion as to whether the rate of oil production was exceeding an optimum; this latter situation, it was pointed out, might injure our fields and reduce the ultimate oil recovery from them.

During the war, there was a general expectation that demand and production would decrease once the war was over. This expectation has not been realized. Instead there has been a gradual increase in production, responding to an apparently insatiable demand. The approximate figures on production are:

1942, one and four-tenths billion barrels;
1947, one and eight-tenths billion barrels.

Major factors in the excess of demand are unrestricted automobile driving, the increased number of automobiles, the wide-spread substitution of fuel oil for coal, the high level of industrial activity, and the requirements for export to a world market which for seventy years has looked to this country for kerosene, gasoline and lubricants.

The welfare of any industrial nation, and indeed of our whole industrial civilization, is tied up with an ample supply of energy available at a low price. The citizen-philosophers, architects and scientists of Athens had leisure for their pursuits because of the slave-labor of the helots. England remained pre-eminent industrially from 1800 to 1875 because of an ample supply of low-priced coal. Our modern helots are now the steam-turbine, the diesel and the gasoline engine; every American citizen, young and old, is now served day and night by upward of ten horsepower, and our current way of life would literally be impossible without this background of steel and copper and fields of force. Our power is supplied by coal, oil, natural gas and water. Very roughly, the fraction furnished by each is:

Coal	43%,
Oil	30%,
Natural gas	14%, and
Water power	12%.

Water power always appeals to the imagination of the average citizen because it suggests getting something for nothing. Actually, it generally requires heavy capital investments and involves expensive transportation of electrical energy from usually remote locations. Petroleum has a form value which renders fairly easy its transportation and use wherever required. Natural gas falls in the same class.

While the use of petroleum as gasoline, tractor fuel, diesel fuel, domestic furnace oil, industrial fuel and bunker fuel for ships represents its predominant value, it has another critical though smaller application. About three per cent of our oil goes into the manufacture of lubricants, supplying essentially the entire needs of our industrial and automotive setup. Our industry is geared to low-priced lubricants and literally nothing else could take the place of petroleum for this purpose. It is true that higher-priced lubricants could be tolerated by industry; also that conceivably plant and animal fats and synthetic chemicals could, given time, supply our lubricant markets. However, there is some question whether we would enjoy the consequent dislocation of our food and fatty oil-using industries; furthermore, whether we would willingly accept the new products. After all, they would probably have quite different chemical properties, perhaps a decreased stability at fairly high temperature, such as that at the top edge of a diesel-engine piston.

Our machine age, it may be said, floats on a film of oil. The film varies from a few to a few thousand molecules only in thickness, but it is very important and it must have the right properties. We may say of petroleum lubricants that they are the cheapest and, at the same time, for all large-scale uses, the best.

Somewhat analogous are the by-product applications, in which something is produced which does not look like conventional petroleum. Examples vary from real by-products like paraffin wax, or petroleum asphalt, which has almost crowded natural asphalt off the market, to chemical derivatives based on petroleum raw materials. It has been estimated that over five thousand products made from petroleum are on the market today.

The oil industry has passed through a series of overlapping stages, which might be listed as

the kerosene lamp-oil stage,
the gasoline stage, and
the diesel fuel and fuel oil stage.

It is now entering the synthetic stage. This latter has currently been represented on a rather large scale by the wartime enterprises, synthetic rubber, aviation gasoline, and toluene for TNT manufacture. In spite of the size of these war time projects, the demand for petroleum raw material was small. Tabulated, they look as follows:

Material	*Amount/yr.*	*Percentage of our petroleum supply*
Toluene for TNT.....	60,000,000 gal.	0.1%
Butadiene for synthetic rubber	600,000 tons	0.3%
Hydrocarbons for aviation gasoline	70,000,000,000 bbl.	6 %

Of course the raw material demands for making these products were larger, but not enough so to change the picture.

To discuss the supply situation for the next twenty-five years would require the gifts of a seventh son of a seventh son. The proved reserves in the United States as of 1947 are about twenty-four billion barrels. This quantity represents twelve and a half years' supply at the present rate of consumption. There is every indication that our consumption rate will increase, and we know of course that we cannot withdraw all our present reserves within the twelve years; the rate of production would drop off gradually and we would have less and less production for a long time. It is also known that the rate at which we are discovering new reserves is less than the present rate of consumption. New oil fields are more difficult to find. The cost of discovering a barrel of oil underground has been estimated at nine or ten cents in 1935, but about fifty cents in 1946, which gives a rough measure of the increasing difficulty. It may be that the removal of artificial restrictions on price, manpower and critical materials imposed in wartime, and the development of new techniques of discovery will change this picture.

If we make the unpleasant assumption that we have already discovered the bulk of our domestic crude oil reserves, and assume further that no new method of producing energy will become practical during our lifetime, we can list the alternative sources of energy as follows:

imported petroleum,
domestic natural gas,
domestic coal, and
domestic oil shale.

The Near East is now known to be a tremendous reservoir of crude petroleum. The availability of this oil, however, depends on the international situation, and we would not wish to be entirely dependent on the Near East in the event of another war. The use of natural gas and coal to produce liquid fuels involves chemical conversions such as the Fischer-Tropsch synthesis, or coal hydrogenation. The Germans used both processes on coal to some extent during the war. The Fischer-Tropsch operation involves converting the base material to a mixture of carbon monoxide and hydrogen, which is then changed by a catalytic reaction to hydrocarbons similar in nature to those of gasoline and diesel fuel. Natural gas is a very favorable raw material for the making of the carbon monoxide-hydrogen mixture. As our reserves of natural gas are roughly of the same magnitude as our petroleum reserves, this conversion of natural gas offers the possibility of extending our supply of light petroleum fuels for some years. It must not be forgotten, however, that natural gas already meets a large demand for domestic and industrial heating, so that only part of it will be available for liquid fuel manufacture. The use of coal as a base for the synthesis is somewhat less attractive, for the methods of gasifying coal are not yet entirely satisfactory. After the coal is gasified, the catalytic conversion is the same as in the synthesis from natural gas. A rough estimate of costs indicates that Fischer-Tropsch gasoline from natural gas may cost twice, and from coal at least three times, the pre-war cost of gasoline from petroleum. Chemical and engineering research on both methods of supplying our needs is being pushed vigorously in this country.

The hydrogenation of coal is receiving less attention at the moment, but is believed by several authorities to have excellent prospects. The process has so far required high pressures and involves some difficult handling problems.

The several operations mentioned are rather expensive, and indications are that none of them could produce heavy fuel oil at a price anywhere near that now prevailing for petroleum fuel oil. The retorting of oil shale offers some hope in this field, but a good deal of development will be required to provide a workable, to say nothing of an economical process. The U. S. Bureau of Mines has an active research project in operation on Colorado shale. One difficulty is that the best and most plentiful

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Light Wave of Mercury 198 as the Ultimate Standard of Length

• By William F. Meggers, Ph.D. *(Johns Hopkins University)*
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The world's standard of length has long been the platinum-iridium bar of France. Scientists as well as industrialists have used it since 1889. But since the standard meter is not sufficiently precise for many scientific measurements, better standards of length have been sought. It has now been discovered that the green line of a certain isotope of mercury has none of the disadvantages of the meter, or the red line of cadmium, and in addition has distinct advantages of its own.

The scientist who writes this article first recommended the adoption of the new standard. It was he who made the measurements that proved its worth. Dr. Meggers received the 1947 Frederick Ives Medal for distinguished work in optics.

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A new and better standard of length now exists in the wavelength of the green radiation of mercury 198, an isotope transmuted from gold by neutron bombardment. In precision, reproducibility, and convenience, the new standard is superior to both the standard meter and the red line of cadmium, according to recent investigations at the National Bureau of Standards. Preliminary measurements have shown an accuracy of one part in a hundred million of relative values, and one part in a billion is theoretically possible.

Since 1889, the world's standard of length has been the "meter" distance between two lines on a platinum-iridium bar at the International Bureau of Weights and Measures in France. Fundamental measurements throughout all of science and industry are based on this standard, but it has several disadvantages. First, line standards are unsuitable in certain fields of measurement. Second, the intrinsic nature of lines ruled on surfaces—such lines are in effect small furrows—limits the precision attainable. Third, the meter is not readily reproducible.

Primarily because the standard meter does not afford sufficient precision in some fields, the red line of cadmium has been universally used for many years for precise measurements. However, the cadmium standard also has serious disadvantages. First, there is a fine structure in the red radiation which prevents the line from being as sharp as desirable and this limits the precision possible. Second, the cadmium standard requires excitation in a furnace, which entails unwanted broadening of the spectral line because of relatively high temperature.

The green line of mercury 198 has none of the disadvantages of either the meter or the red line of cadmium. The normal human eye is far more sensitive to green than to red, an important consideration in visual adjustment of the interferometer with which lengths are measured and compared. All other characteristics desirable in a light wave standard—such as ability to be reproduced, absolute sharpness of the wavelength, intensity of the spectral line, life and convenience of maintenance—are possessed to a greater extent by mercury 198.

The future refinement of physical optics, for example, an accurate determination of the velocity of light, and the improvement of mechanical processes, for example, the ruling of better diffraction gratings, are dependent on the production and adoption of an ultimate standard of length superior both to the meter bar and to the wavelength of red radiation from cadmium. The nuclear reaction that now makes possible large scale transmutation and the manufacture of pure elements not found in nature, will also produce any desired quantity of the pure mercury from gold, and thus provide a material for a spectroscopic light source that emits light waves much more monochromatic than any emitted by natural elements. Theoretically, mercury isotope 198 should show interference patterns with retardations exceeding a million waves, and because it is possible with monochromatic lines to measure one-one thousandth of a wave, it is probable that the relative value of Hg^{198} wavelengths may eventually be determined with an accuracy of one part in a billion.

As long ago as 1927, the National Bureau of Standards recommended that the International Conference of Weights and Measures adopt a light wavelength, that of red radiation from cadmium vapor, as the primary standard of wavelength, and that the meter be defined in terms of this wavelength. The Conference objected that such a definition of the meter would menace the metric system, and explained that it was not a question of giving a true relation between the meter and the wavelength, but only a metric value of the latter which could be modified by future experiments. Strictly speakin, the world's primary standard of length is still the distance between two relatively wide lines drawn on a metal bar, despite the fact that practically all precise measurements of lengths in the 20th century have been made, and will continue to be made, with light waves.

The most monochromatic spectral lines are emitted by massive slow-moving atoms, and because mercury atoms are nearly twice as heavy as cadmium atoms and can be excited to radiate at less than half the absolute temperature, mercury lines are less than half as wide as cadmium lines, other things being equal. Wavelengths from natural mercury cannot be used as standards of length because natural mercury consists of a fixed mixture of

seven isotopes with atomic masses of 196, 198, 199, 200, 201, 202, and 204, and each isotope emits one or more spectral components none of which are exactly coincident. Consequently, the green line of natural mercury has sixteen components.

Because the effective wavelength of such a complex line observed interferentially varies with the phase relations of the various components, it is imperative to avoid complex lines in selecting a natural standard of length. This objectionable feature of mercury lines could be removed if a single isotope, for example Hg^{204}, could be separated from the rest, but up to the present it has not been practicable to isolate an isotope of natural mercury in sufficient quantity to make satisfactory lamps. However, this goal has now been achieved by transmuting gold (Au^{197}) into mercury (Hg^{198}). The feasibility of doing this was first demonstrated, in 1940, by J. Wiens and L. W. Alvarez who reported that bombardment of gold by neutrons from a 60-inch cyclotron at the University of California produced enough mercury to be detected spectroscopically.

HERE DR. WILLIAM F. MEGGERS of the National Bureau of Standards operates the optical train used to obtain relative values of the wavelengths of mercury isotope 198—transmuted from gold by neutron bombardment. The green line of this isotope, whose wavelength can be measured with an accuracy of one part in one hundred million, offers a new standard of length superior to both the meter bar and the wavelength of red radiation from cadmium. Light from the electrodeless mercury lamp (left), excited by high frequency radio waves, and from the cadmium lamp (center) passes simultaneously through a Fabry-Perot interferometer into a prism spectrograph (right) where interference patterns of each spectral line are photographed. Relative values of wavelengths are derived from measurements of the interference pattern.

In 1942, the National Bureau of Standards purchased forty ounces of proof gold and enlisted the cooperation of the University of California to expose this gold to neutrons for one or more years. Unfortunately, World War II interrupted the experiment and only sub-microscopic quantities of artificial mercury were made. The prospects were very discouraging until, near the end of the war, there were rumors of a secret source of neutrons thousands of times more effective than the largest cyclotron. In 1945, the National Bureau of Standards' gold was transferred from California to Tennessee. The treatment this gold received was not disclosed but a year later the Bureau distilled from it about 60 milligrams of mercury, which was found from spectroscopic tests to be pure Hg^{198}. Anticipating a considerable demand for Hg^{198} lamps the Bureau has requested the Atomic Energy Commission to bombard some more gold with neutrons to produce one or more grams of Hg^{198} within a year. In the meantime, the available Hg^{198} has been used by the author in the preparation of several types of lamps which are being studied to determine the one most suitable for adoption as a standard.

In the design of a Hg^{198} lamp that will emit radiations suitable as ultimate standards of length a maximum is desirable in each of the following five characteristics: (1) monochromaticity, (2) reproducibility, (3) intensity, (4) life, and (5) convenience. It is perhaps obvious that some of these requirements conflict with others, and that it will be necessary to make compromises. It appears probable that either electrodeless tubes or Geissler tubes (similar to the ubiquitous luminous signs), containing several milligrams of Hg^{198} and a small amount of argon gas will be useful for accurate measurements.

Employing an electrodeless lamp excited by high frequency radio waves, preliminary values of the wavelengths of a dozen Hg^{198} lines, ranging from the ultraviolet (3341 A) to the yellow (5791 A), have been measured. Though publication of the observed wavelengths of Hg^{198} will be deferred until final values are in hand, these preliminary values, when tested by the combination principle of spectroscopy, appear to be correct within one part in one hundred million, whereas the best measurements made with natural mercury exhibit deviations of one part in one-hundred thousand, due, no doubt, to the falsification of the wavelengths by the complexity of the lines.

Although cadmium and mercury are divalent chemical analogues, and therefore exhibit relatively simple and similar atomic spectra, whatever differences exist are invariably in favor of mercury. For example, the brightest line in the cadmium spectrum occurs in the blue-green (5086 A), whereas the mercuric analogue is in the green (6451 A) nearly coincident with the maximum sensitivity of the normal human eye. The red wave of cadmium (6438 A) is intrinsically only one-tenth as intense as the strongest line (5086 A), and is further handicapped by the fact that the eye is only one-seventh as sensitive for red as for green. Thus for the visual adjustment of interferometers the green line of mercury is seventy times as intense as the red line of cadmium. The mercury analogue of the cadmium red line is a yellow line (5791 A) which is always accompanied by another yellow line of shorter wavelength (5770 A) but

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A University Chart and Graph Service

• By Robert A. Jones, Supervisor,
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Although their use has long been common in primary and secondary schools, visual aids of various kinds are now employed increasingly in college classes. But satisfactory aids for any teaching level are not easy to obtain. The best are often those that are specially designed and executed by skilled workers under the direction of the teachers who will use them.

This is a brief account of how one university meets the demand on its own campus for such instructional aids. It contains information concerning materials and procedures that will interest every teacher who has ever made, or who intends to make, classroom charts, graphs, maps, or other similar teaching devices.

Ohio State University personnel who have been intimately acquainted with the Chart and Graph Service in the period of its development are enthusiastic about it. This service was begun as a division of the Teaching Aids Laboratory during February, 1947. It was conceived on an experimental basis as an additional source of instructional aids for the University teaching staff.

The Chart and Graph Service is housed in a temporary building. From various departments unused drawing boards, desks, stools, and tables were obtained for the studio. The University provided funds for other necessary equipment. In order to provide a staff for the studio, one full-time artist was hired to locate and supervise a group of part-time student artists. Most of those employed are specialists in producing one type of material for the Service.

It has been necessary, in the interest of fairness to all departments, to put a tentative limit on the amount of time spent by artists on projects for any one department—thirty hours of free service in any one quarter. If a given project requires more than thirty hours, the department requesting it is expected to pay the student-artist part-time labor cost.

Instructors for whom work has been prepared report greater effectiveness of their teaching efforts and bring other "customers" back with them. Apparently, the prime effectiveness of the Service is the result of the materials being especially streamlined for each teacher's purposes. He sees them develop as he helps plan their presentation, and he makes the final test of classroom effectiveness himself.

The process of obtaining a chart, graph, or poster from the Service is relatively simple. The instructor gathers the data that he wishes to have presented in graphic form and brings it to the studio. There he consults with the supervising artist on the best means by which it can be presented to his students. Some types of material develop better in the form of large charts; others in smaller form for individual copies to the students; while still others seem best in the form of lantern slides or filmstrips. If the instructor has not decided previously which of these he wants, the advantages and disadvantages of each are discussed with him as a basis for his final decision. If the decision calls for a large chart, the optimum size must be determined in terms of the number of students in the class and the size of the classroom.

An example of the type of projects brought in by many instructors is the construction of large charts, three by four feet or larger, on which lettering predominates. Such a chart contains the type of material ordinarily placed on the blackboard before a lecture. A better presentation method than the blackboard is thus provided by using colored paints and various sizes of letters for emphasizing essential points. This work calls for an artist skilled in brush lettering. Other similar projects may call for an expert in the use of speed-ball pen lettering if a neat, highly legible job is to result. Still other projects call for skill in the making of special maps or in illustrating different types of subject matter. Some of the student artists are skilled in more than one of these specialties. Experience has shown that by combining the skills of several of the specialists a better quality product is obtained than by having one artist who is fairly good at all operations complete the job.

Most of the larger charts called for by instructors are produced on coated fabrics such as sign cloth, chart cloth, or oil cloth. On these materials enamel sign paints, water solvent poster paints, and inks may be used. A few large charts have been made on illustration board and poster board. Illustration board seems to be best for projects requiring fine-detailed illustration work or the use of water colors. Because of the difficulty of obtaining these materials, it has sometimes been necessary to use a particular fabric or board because it was the only thing available. A non-glossy, heavy oil cloth seems to be the most desirable material on which to paint the larger charts. This type of cloth will not crack or wrinkle easily; it is easy to clean, and it will take enamel paints well. Since charts in most university courses are not used continually, these factors are important.

When charts are stored between periods of use they may absorb moisture. Ordinary sign cloth and chart cloth will wrinkle and ripple from dampness picked up in the coating of the fabric, while the oil cloth is prac-

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Why Science in the Elementary School?

• By Sister M. Aquinas, O.S.F.
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This paper, the first of a series, considers the many reasons why science should be taught to children, even the very young. Understandings, attitudes, and habits concerning man and nature are easily developed through a science, health and safety program. The child's concept of God is deepened, he may learn how to conduct the affairs of his daily life more intelligently, and he is stimulated to discover new knowledge. There are other benefits.

Future articles of this series will consider Planning a Grade School Science Program, Evaluating the Elementary School Science Program, and Spiraling Science Understandings to be Learned at Different Grade School Levels.

This is the *Age of Science*, an age that challenges the mind of the modern boy and girl at every turn. His curiosity is aroused not only by the behavior of plants, animals and other creatures of earth, sea and sky, but also by application of 20th century inventions.

This is the *Air Age*. Practically all children are interested, if not actually intrigued, by the airplane, the helicopter and rockets.

This is the *Machine Age*. The child operates machines, or sees them serve his needs at home, in the school and the community. His inquiring mind wonders how machines work, where they obtain their energy, why they do strange and wonderful things.

This is the *Age of Electricity*. The child sees uses of electricity even in his pre-school experiences. He asks questions about it. What is electricity? What causes it to work? He has an interest in electrical toys, in lamps, radio tubes and household appliances that use electrical power.

This is the *Atomic Age*. School children read about the atom and try to interpret pictures showing the use of atomic power. Their minds are eager to learn about this intricate problem, and a little education in it enables them to follow through farther, and to understand some of the workings of atomic energy. They begin to realize its impact on social problems.

In recent years many Catholic elementary schools have planned a program of science, health, and safety as an essential part of the growing child's curriculum. The schools consider this necessary to enable the child of today to meet many situations that the child of yesterday was not required to meet. It is an effort on the part of the schools to meet children where they are thinking—in the field of science.

I

Man is the highest creature in life on earth because he has a mind. The possession of the gift of mind gives man the faculties of intellect and will. These faculties make man a responsible creature, responsible to God for himself and his fellowman. Because man has a mind he can aspire to God. He can form Christ in himself. The true aim of all Christian education is to help the growing child to form Christ in himself; to arouse the child to awareness of his responsibilities in the four basic relationships of life—relationship to self, to God and the Church, to fellowman, to nature.

All elementary schools provide for experience whereby the child works toward self-improvement. He is taught to develop himself by skills in speaking, reading, writing, spelling, numbers, singing and other forms of expression. He is helped to develop certain understandings, attitudes and habits concerning his relationship to God and the Church through an organized course in Religion. His relationship to fellowman and to his country is strengthened through the Social Studies, including history, geography and civics. This study complements that of Religion.

Many schools are now emphasizing that fourth relationship, the one to nature. They realize that the child must live properly in this relationship and develop responsibility in it. Understandings, attitudes and habits concerning man and nature are best developed through a science, health, and safety program.

Two factors of growth are sought in such a program: appreciation of natural phenomena, and correct knowledge, attitudes and habits in the use of natural resources. A study of nature and its laws deepens the child's concept of God. It broadens powers to preserve health, to make a living, and to consume intelligently the material gifts God bestows through nature. A study of nature and its laws enables the child to understand his environment more fully and adjust himself to it more efficiently.

A study of living creatures, plants and animals, brings to the attention of even the youngest child the fact that in His Providence God has planned for each creature the kind of covering, home, food and means of protection that is best for it. The child will realize that animals obtain these necessities through instinct, which compels them to carry out the Divine law in nature. He will soon come to see how much greater than the animals is man, who can freely follow the plan of the Creator and understand his own actions while doing so.

A study of movement in things living and non-living, of sources of power that move them, helps the child to realize that God is the First Mover of all things. He

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Can the G. I. Way be Applied to Civilian Teaching?

• **By Alonzo G. Grace, Ph.D.** *(Western Reserve University)*
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The success of the military leaders of World War II in providing speedy training in special areas of knowledge directed sharp attention to current methods of educating civilians. Although wartime teaching differs from peacetime instruction in immediacy, in motivation, and in financial and personnel resources, it does provide certain lessons for educators.

Dr. Grace has made a careful study of the question. Here he points out the need for a national purposing in education coupled with an improved local initiative and responsibility. Curriculums should be revised. Improved health and physical fitness programs are demanded. There should be better schooling in accuracy, in independent thinking, and in leadership.

What were the outstanding characteristics of the wartime educational programs conducted by the Army and Navy?

What lessons can we learn from these G. I. programs, and what should be the goal of future educational programs for civilians?

The first question was raised during the war by educators who were in the service, by civilians who had observed the training, and by others who were convinced by the literature on the subject that considerable change was in store for civilian education in this country.

The American Council on Education early in the war identified this problem and appointed the Commission on Implications of Armed Services Educational Programs in the summer of 1945. Its function was to identify features of the wartime training and educational program worthy of adaptation and experimentation in peacetime civilian education of all types and levels. The particular problem was to make available to the public well-considered answers to two questions: (1) "What should education in America gain from the experience of the vast wartime training effort?" and (2) "What are the lessons for education and the national culture and strength now and in the future?"

Many published articles describing the armed services training and educational programs have attributed to them influences or impacts which emanate from the general effect of war on social institutions. The impact of war service on individuals no doubt will affect civilian education. The war also revealed certain gaps, imperfections, or weaknesses in American education, and, likewise, the armed services made mistakes in the development of programs. These are aspects of the general impact of war on civilian education that have been treated only incidentally.

Before the formulation of the project, the approval and cooperation of the Secretary of War and Secretary of Navy were obtained through official channels. By this means the Director and staff of the Commission were given full cooperation by military and naval personnel in Washington and in the field, and cordially received as visitors and observers at many types of military and naval training installations during the late summer and autumn of 1945, before the postwar curtailment and dismantling of training facilities had proceeded to any great extent. The official cooperation of the War and Navy Departments also made possible the prompt clearance of the several reports of the commission's staff for public release.

Certain general observations may be made as a result of this study. Among these are the following:

1. The general character of the Army and Navy training and educational programs properly can be classified as job-training and indoctrination, all colored by specificity. There are lessons in methodology for specific training, but few lessons in intellectual freedom or a liberal education. It is important to know, however, that these programs largely represent training for a specific operation.
2. Advantages in the form of abundant resources of money and of personnel, and of the strongest motivating factors, accrued to the armed services in wartime; but despite these differences, comparison of their methods and programs with those of American civilian education is profitable, and yields lessons for the development of the nation's human resources.
3. The armed services necessarily had to operate on a trial-and-error basis. They had to produce the maximum results in the minimum of time. If a program failed to produce results, immediate changes were ordered. They were not hampered by the tradition of a generation.
4. Little developed in the education or training methods, procedures, practices, or programs that was not already known to civilian educators or that was not the result of leadership from civilian education. In other words, the major developments in the armed services were accomplished by civilian educators recruited for purposes of training or by methods and procedures that were taken over by the military.
5. Aside from lessons for the improvement of American education in time of peace, the wartime armed services training experience contributed to the services themselves a great deal of advancement in training methods, useful in their permanent task of guarding the national security.

If all the studies in our several states and at the national level of all American education were implemented and the recommendations contained therein were placed in effect, substantial modification would occur, no doubt, not only in the program but in the structure of American education.

The building of our armed forces of approximately twelve million men and women in a nation which had given little thought to the preparation of youth for world citizenship was a formidable task miraculously accomplished. In the light of our general nation-wide aversion to war, our faith in the capacity of human beings to settle political problems without force, our naive faith in the security of two oceans and the power of the United States always to emerge victorious somehow or other, we developed a training program in a relatively short time, and a military force unsurpassed among the armies of the world was placed on the battle front.

The Armed Service Forces early in the war adopted the slogan "The Impossible We Do At Once; the Miraculous Takes a Little Longer." It was this spirit that dominated our total war effort, not only in the selection and training of the combat force but also in the recruitment and training of the production army and the civilian defense organization—for this was total war.

General Marshall has said that time was the factor that spelled the difference between victory and defeat for our country in World War II. He further stated:

> "In all good conscience this nation can take little credit in staving off disaster in those critical days. It is certain that the refusal of the British and Russian people to accept what appeared inevitable defeat was a factor in the salvage of our civilization. Of almost equal importance was the failure of the enemy to make the most of the situation."

From pitifully small beginnings we mobilized our total resources, human and material. Once the crisis became evident to our citizens, all activity was directed toward the attainment of the common victory. The end became more important than the means to the end.

The Nature and Organization of Training

The purpose of all wartime training was victory in combat. It was to train the soldier and his unit to meet the enemy and to destroy his military effectiveness. No matter how remote or how close to the war a particular type of instruction might have seemed, its ultimate aim was always the same. The training of watch repairers at Aberdeen, Maryland; of infantry riflemen at Camp McClellan, Alabama; of pilots at San Marcos, Texas; and of engineer riggers at Fort Lewis, Washington, had one common objective; namely, the systematic destruction of the enemy's manpower and resources under whatever conditions they were encountered.

To attain this objective, training was planned to develop in individuals the ability and desire to take the offensive. If instruction included defensive skills, they were used only as a means to the final end; namely, offensive action. The objective, above all else in armed service training, was the creation of aggressive, resolute, thoroughly capable individuals and units whose skill, initiative, and competence would instill in them a desire to close with the enemy and destroy him. This, then, was the ultimate objective of military training and education.

It is obvious that only a preview of these implications may be discussed at this time. I propose, therefore, to select four or five areas which hold lessons for civilian educators with the hope that you will read the final report of the Commission for the total picture of this most important development.

The Administration of a Civilian Program

By necessity, the education and training programs of the armed services were highly centralized. Standardization characterized the entire program. This is in distinct contrast to the American educational system where the state is the agency responsible for education, the administration of which properly is delegated to the local communities. With this system there can be no quarrel, for any observation of the totalitarian procedures abroad will indicate the vulnerability of a highly centralized system of education. Through the Ministries of Education in France, Germany, Italy, Russia, and other countries, the ideologies of the prevailing powers are reflected. We can avoid this system in our country by making local initiative and responsibility function. On the other hand, there is need for national purposing in education; there is need for the coordination of our educational effort; and above all, there is need for unity in the American educational enterprise. In my judgment, the improvement of local initiative and responsibility is one of the most important problems that confronts us.

The present era requires that the interpretation of leadership must be power *with* people, rather than power *over* people. The primary functions of leadership are (1) to execute as simply, effectively, and as rapidly as possible the policy, program and procedure of the policy board, (2) to eliminate the impediments to effective execution of policy, and (3) to secure the maximum coordination of human resources required to activate the policy and program.

The educational organization is a human and not a mechanical organization. We do not organize to perpetuate or develop vested interests or compartments or to become isolated from the principal mission. The job is to provide the most effective education and educational opportunity within the limits of the financial resources, the ingenuity, the vision and the realism of the members who comprise the whole. We must operate in the interests of the general welfare.

To understand the nature of democratic administration, it is essential that we consider some of the elements involved therein. These include:

1. The right to be employed and to participate fully in all phases of the activity of the organization without regard to race, creed, nationality, political preference or other irrelevant factors.
2. Respect for intellectual integrity and the right of private judgment; the right and responsibility to be heard on matters concerned with the total program of the organization.
3. The responsibility to accept responsibility.
4. The willingness to work toward the attainment of the common goal at the expense of personal convenience or interest.
5. Willingness and opportunity to share in the development of the policies and program of the organization.
6. Obligation to abide by rules and regulations which each has helped to initiate.
7. Capacity to permit the general welfare to supplant personal or group selfishness.
8. Capacity to recognize the fact that decisions must be made, and the ability to aid in promoting action and decision.

Rules and regulations must be adopted in the light of the frailty of human nature. We have not abandoned the police force or the court in our society, but common sense must prevail at all times in the administration or the observance of rules and regulations. Administration is merely an aid to the effective execution of the mission of the policy board. If the time comes when administrative detail requires more time than educational planning, then the principal goals of education will have been defeated. We have much to learn with respect to human relations.

Another aspect of our civilian education program which needs to be studied carefully is that of curriculum revision. Certain major issues relating to the education program and the armed services programs follow:

(1) Can we continue to add to the curriculum, year after year, without eliminating at some point? What shall be eliminated?

It is with ease that we add to the curriculum, but few suggest the areas which may be eliminated. Within the armed services, the instructor is presented a picture of a target—the bull's eye represents the information that *must* be learned. Around the bull's eye is a circular area which represents information that should be known. The outer fringe of the target contains an area described as information well to know, but which can be omitted without harm to the course or the individual. In civilian education the "will to know" is important in the development of an education for living. It seems to me that we have a job ahead in the re-appraisal and re-evaluation of the parts of the educational program.

Even more important is the matter of additions to an already overcrowded educational program, at the secondary school and college level. We cannot teach all things to all people. It does not seem wise that the program be extended upward and downward before we have supported a common school system universally throughout this country. It is suggested, therefore, that we:

a. Re-appraise and re-evaluate the course content of the individual parts of the curriculum.
b. Agree on a common body of knowledge as the basic minimum to be possessed by everyone.
c. Ascertain what can be profitably eliminated when new elements are added to the curriculum.

(2) Shall we be able to coordinate our educational effort to the end that all community resources may be brought into harmonious working relationship?

One of the great impacts of the war is that relating to the health and physical fitness of our youth. The great number of rejections by Selective Service is a fact known in practically every community, but these facts in large measure were known prior to the war through studies by the American Youth Commission and by the National Youth Administration and others. The main question now is: Shall we continue to beat the drums against the coordination of community enterprises, or shall we initiate a nationwide community development in this area? The utilization of our total resources will include:

a. A willingness on the part of schools, health and recreational interests to combine their resources in the interest of children, youth, and adults in the community. The spirit of separatism which prevails in many communities should be eliminated in the interest of the common welfare. The vested interests or compartments in social organization are not independent entities operating in the interests of themselves—the goal is community service for all children.
b. Capacity to bring together as a planning committee—possibly parts of a local community planning committee—an over-all committee on health, recreation, and physical fitness; and develop from that the courses of study, experiences, and services which are essential in the development of a sound, effective community program.
   This cooperative curriculum planning may extend into the field of conservation education, social studies, or indeed into practically every other area in the educational program.

(3) In the consideration of the goals of American education and the present general trend toward individual differences as a basis for instruction, shall we not also consider individual similarities as a basis for education?

As a means to more efficient learning, the general trend has been toward the development of curricula in which there has been recognition of individual differences. This is an entirely justifiable means of securing economy in learning and providing the very best environment for the individual as a learner.

(4) Is it desirable that standards be developed for American education? Or shall we avoid this issue merely by stating that there are as many standards as individuals? Is evaluation a better substitute?

(Continued on Page 67)

Experiential Physics

• By H. Clyde Krenerick
NORTH DIVISION HIGH SCHOOL, MILWAUKEE, WISCONSIN

Here is practical help for the physics teacher in the secondary school who desires to improve and enliven his laboratory teaching.

The writer is a successful teacher who knows the value of the right kind of laboratory instruction, and who has experienced at first hand the difficulties commonly encountered in the high school laboratory. He has learned how to avoid or to overcome a number of them.

Mr. Krenerick, is an expert at devising simple but effective apparatus, much of which can be made at home. Some of it is pictured here.

●

During thirty years of experimental research in the teaching of physics we have devised a number of methods and experiments that have proved to be of high instructional value. Twelve are described in this paper. Others were discussed in an article "A New Laboratory Method of Teaching Physics" which was published in the June, 1937, issue of *The Science Counselor.* All these experiments and a number of others appear in our laboratory text which we call *Experiential Physics.*

Every method, every experiment, every piece of apparatus in the laboratory manual has been tried by hundreds of students. If they failed to give the desired results, we revised and remodeled them until they were completely satisfactory. Under our plan of instruction the student by his own unaided study and performance in the laboratory can and does discover for himself the fundamental principles of elementary physics. Our textbook assignments and discussions follow, not precede, the laboratory experiments. The work the student engages in is for him "original research". He is self-taught.

To make this method a success, many experiments must be performed. We have devised 37 of our own which we use in connection with some 50 standard experiments. These are enough to introduce practically all the fundamental principles. To obtain the best results, students must work individually. If duplicate sets are to be provided, the required apparatus must be simple and inexpensive. It helps, sometimes, if it can be home-made. The illustrations accompanying this article show only a few of the new arrangements we have devised.

To aid the student in interpreting the instructions in his laboratory manual we supply a photograph of the set-up for each experiment. The student must learn what he is going to do and how he is going to do it before he enters the laboratory. Experiments must never be performed mechanically. To substitute a specified number in a given formula or equation is a mechanical process. It requires no thinking on the part of the student. We give no such formulas. No item in the tabulations can be solved by substitution in a memorized formula. Each problem requires two or more steps of computation based on at least a little reasoning.

One of the common criticisms of any method of laboratory teaching is that the pupils do not study the experiment enough to know what is to be determined, and when they are through they do not understand what they have accomplished. To lessen such difficulties we do not state beforehand the purpose of each experiment. After the pupil has been given an opportunity to study the instructions and computations, he is required to state in his own words just what is to be determined. This is part of his home work. It ensures previous study and analysis of the experiment.

To encourage other teachers to use the method of instruction we have found so successful, we have made *Experiential Physics** available to all. It may be used as a manual or as a workbook. Beginning teachers find its method of self teaching—student preparation and student demonstration—especially interesting. Science teachers in the smaller high schools where many preparations are necessary find our method of recording and checking a great aid and convenience.

Here are brief descriptions of some of our newer experiments and apparatus. The numbers refer to the photographs. If teachers are unable to make the pieces described, most of them may be procured from the Chicago Apparatus Company.

1. Laws of the Pendulum

An electric kitchen clock with a six-inch dial can be obtained at one-tenth the cost of a stop-watch. By watching the movement of the second hand, a student can determine the time of a signal to the tenth of a second with considerable accuracy.

The homemade pendulum clamp is a bar of wood ⅝"x⅝"x8". Near one end of the bar is a small bolt with two washers and a wing nut. The suspending cord is easily placed and firmly held between the washers.

2. Accelerated Motion Plank

A plank 1½"x3"x60" with a shallow groove in the top edge. Can be made by putting together two ¾"x3"x 60" pieces with a slight bevel on one edge. The pendulum makes a complete vibration in one second. With this apparatus the distance the ball rolls during each of the first two seconds is obtained, and the acceleration determined. The formulas are discovered, not merely applied.

**Experiential Physics* by H. Clyde Krenerick, 3000 N. Maryland Ave., Milwaukee 1, Wisc. Net, $1.00. See page 73.

This type of acceleration apparatus makes possible three more instructive experiments: Newton's Second Law of Motion, Relation of Absolute and Gravitational Units, Measurement of Kinetic and Potential Energies.

3. Gay-Lussac's Law—Pressure Coefficient

For finding the relation between the absolute temperature and the pressure of a confined gas when the volume remains constant. By placing the flask in cold water and then connecting it to the closed manometer, the initial readings are the temperature of the cold water and the atmospheric pressure. For a second set of readings raise the flask and lower it in a jar of hot water. The resulting pressure is determined from the closed manometer. The change in the manometer level is a slight change in volume. About 0.4 of one per cent error.

4. An Optical Bench

An optical bench for the study of mirrors, lenses, microscopes and telescopes. The bench and the holders are all obtained from apparatus already in the laboratory. A large extension clamp is a perfect holder for lenses and a 75 mm. mirror. The object is the filament of a ten-watt clear glass lamp. With this object cheap lenses and mirrors give very satisfactory results and a darkened room is not necessary.

5. Efficiency of Gas Heating

A Bunsen burner is a gas stove with an efficiency very much the same as other gas burners. A gas meter to determine the amount of gas used is a very expensive instrument. Here the rate of flow is determined by means of a T-tube with an open water manometer connected to the vertical arm. The number of cubic feet per hour is determined from the difference in levels of the water in the arms of the manometer. No extra apparatus is needed and each student has his own meter. The cost of a 1000 B.T.U. is computed so that, later, gas may be compared with electricity as a source of heat.

6. Resistance Board and a Resistance Box

This may be used not only for the demonstration of the laws of resistance, but as a resistance box containing the known resistances needed in all of the experiments in electrical measurements. Wires m and n differ only in length. N and r differ only in diameter. M has 1 ohm, n 2 ohms and r 5 ohms. The amount of resistance used depends on the binding posts connected rather than the plugs removed. This has a very valuable advantage over the standard resistance box in that two resistances can be connected in series or in parallel.

7. Pressure Within Liquids

This apparatus is for showing that the pressure at a given depth is the same in all directions. It consists of a right-angle tube with long and short arms. For determining the side pressure the short arm is placed in a horizontal position near the bottom of a battery jar. For upward pressure place the long arm in a vertical position in a tall jar. The pressure is measured by an open water manometer.

8. Lamp Board

This board makes possible a very good and practical experiment on the magnitudes and connections of electric lamps. No A.C. meters are required. The wattage and the voltage given on the lamp are sufficient. The position of the binding posts makes it possible to connect in series or in parallel without crossing the wires.

9. Efficiency of Electric Heating

An electric heater consists of a heating element surrounded by the substance to be heated. An electric lamp placed in water is an electric water heater. Using the wattage given on the lamp no A.C. meters are necessary. The efficiency of the electric heater is determined, also the cost of 1000 B.T.U. This compared with the cost of 1000 B.T.U. with the gas heater makes an interesting study.

10. Radiations of an Electric Lamp

The purpose of this experiment is to find what per cent of the energy radiated from an electric lamp is light energy, and what is lost as heat energy. If the bulb is placed in water in a metal vessel no energy escapes as light. It is converted into heat. If a glass vessel is used, the light energy passes out, and only the heat energy is received by the water.

11. Steam Generating Apparatus

The standard steam generator, Apparatus A, costs from four to five dollars. Here is a generator that costs only the price of a rubber stopper, fourteen cents. A very satisfactory generator for all experiments in heat is a number 1 can, (beer can) with a two-hole rubber stopper, number 13. The boiler is firmly supported at any level with the large extension clamp.

12. Efficiency of Different Types of Electric Stoves

To determine the relative efficiencies of different types of electric stoves is an interesting and practical experiment. In the electric hotplate the heating element is exposed. In the other heater, a coffee percolator with the coffee basket removed, the heating element is enclosed in the base of the instrument. The cost of 1000 B.T.U. is again obtained so that gas and electric stoves may be compared. The wattage is given on the base of the instrument and no A.C. meters are required. ●

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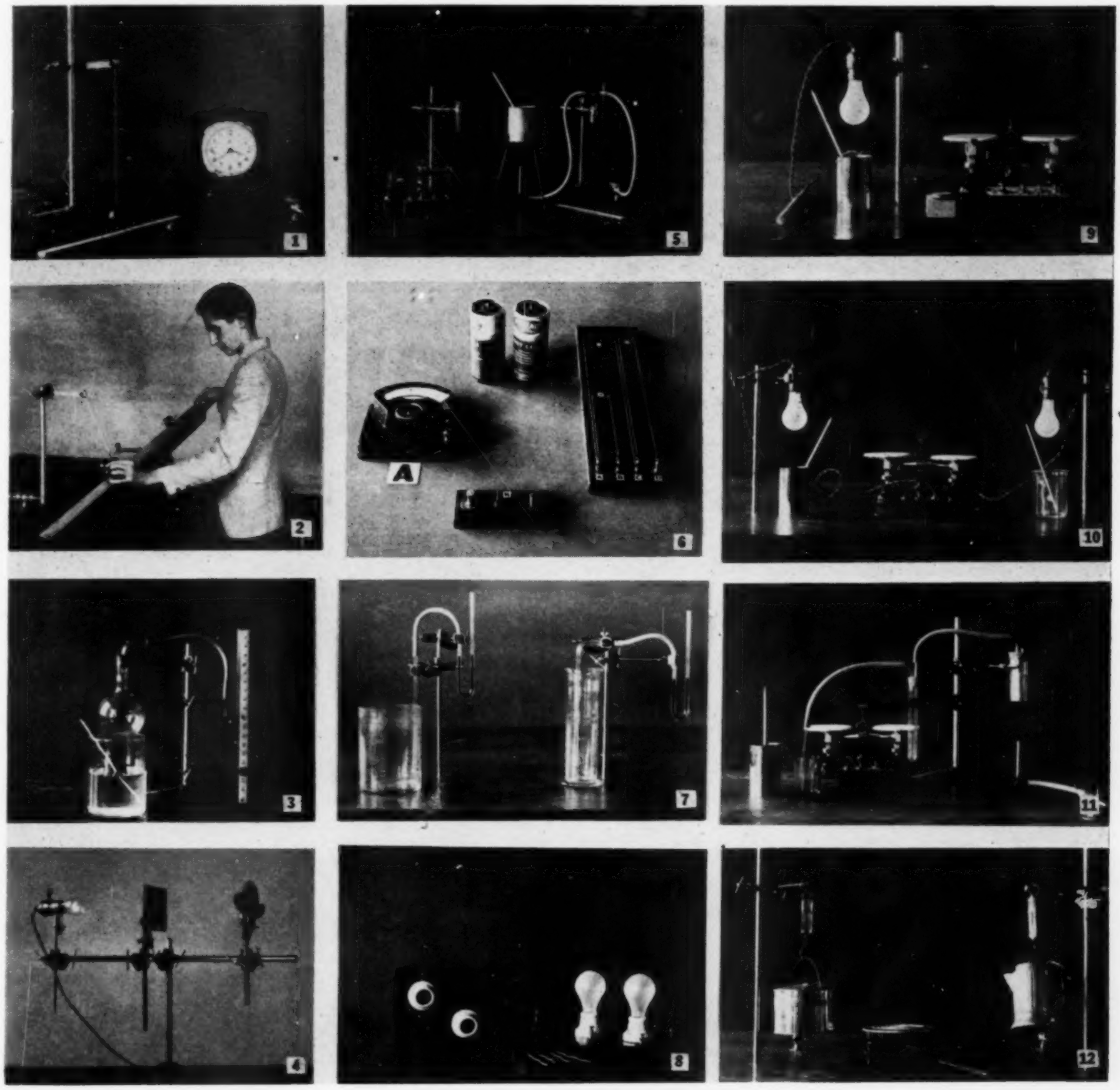
Education is a polite form of mental exercise unless the student feels for himself the tang of original thinking, the bite of new ideas, and the heat of social and intellectual controversy.

Harold Taylor
President, Sarah Lawrence College
Association of American Colleges *Bulletin*



INEXPENSIVE LABORATORY APPARATUS

Devised by Mr. Krenereck and described in the accompanying article

Presenting the Atomic Concept of Energy to the Second Year College Class

• By George E. F. Brewer, Ph.D. *(University of Vienna)*
HEAD, DEPARTMENT OF CHEMISTRY, MARYGROVE COLLEGE, DETROIT, MICHIGAN

Should more physical chemistry be taught in the early years of the course in chemistry?

Dr. Brewer believes that college students benefit greatly in their later study if they are given in their second year a good working knowledge of the behavior of subatomic particles.

Here he outlines his method of teaching the atomic concept of energy. A number of illustrative test problems are included.

It is customary to introduce the concept of subatomic structure to college freshmen in the course of general chemistry. This concept is then used to increase the understanding of the great variety of observations, both chemical and physical, which are embodied in the periodic law of elements. Subsequently, during instruction in analytical chemistry and organic chemistry, reference is frequently made to subatomic structure, apparently, however, without giving additional information on the behaviour of the subatomic particles themselves. The chemistry major, qualified through prerequisite studies, is then admitted to a course in physical chemistry. The atomic concept of energy, the fundamentals of quantum theory and quantum mechanics, are then presented.

This situation has several disadvantages: It brings about a heavy load during instruction in physical chemistry, it deprives the students of a valuable tool in the understanding of various phenomena (like emission and absorption spectra, dissociation, photo-synthesis, etc.) which are presented, and, finally, it results in the fact that non-chemistry majors, while taking up to 24 semester credit hours of chemical instruction, are not even given the semblance of a working knowledge of the most fascinating and fundamental gains science has made during the past fifty years.

An attempt should be made, therefore, to give instruction in the atomic concept of energy in second year chemistry. It goes without saying that the presentation of this concept during the course in analytical chemistry has to be confined to the junior college level and should, therefore, not go beyond the application of Bohr's Theory of Balmer's Terms, while introductory wave and quantum mechanics should be reserved for later presentation.

To facilitate the teaching of "The Atomic Concept of Energy" we have prepared the following material for student use and have employed it with good results.

The Atomic Concept of Energy

For the qualitative determination of the ions of the alkali and alkaline earth metals the direct vision spectroscope is used in conjunction with flame tests. The emision of only certain wave lengths of light by the heated vapors of the metal ions is one of the indications for the existence of a "structure" of the atom and a "mechanism" for the emission of only certain wave lengths. The emission spectrum of each element shows a great number of lines. These lines seem to be spaced in shorter and shorter intervals, converging towards a certain wave length. Beyond this so-called "series limit", continuous emission of all shorter wave lengths takes place. A typical spectrum, the hydrogen spectrum, is shown in Fig. 1. The regularity in the spacing of the lines induced J. J. Balmer to develop an empirical equation for the computation of the wave lengths of these lines:

$$\lambda = \frac{9.12 \times 10^2}{\frac{1}{4} - 1/p^2} \text{Å},$$ where $p = 2 + 1$ for the longest wave length observed ($H\alpha$).

The "p" subsequently increases in whole figure steps toward infinity, corresponding to the wave length of the series limit. Å means "Angstrom", the unit used for such small sizes, 1 Å being 1×10^{-8} cm. Table I shows the wave lengths observed for various lines of the hydrogen spectrum and the values computed by the use of Balmer's equation.

TABLE I
Balmer Series of Hydrogen

Line	*Wave length observed* Å $= 10^{-8}$ cm.	*Wave length computed* $\lambda = \frac{9.17 \times 10^{-6}}{1/2^2 - 1/p^2}$ cm.	p
$H\alpha$	6,563	6.561×10^{-5}	$2 + 1$
$H\beta$	4,861	4.851×10^{-5}	$2 + 2$
$H\gamma$	4,341	4.343×10^{-5}	$2 + 3$
$H\delta$	4,102	4.108×10^{-5}	$2 + 4$
$H\epsilon$	3,970	3.966×10^{-5}	$2 + 5$
.	.	.	.
.	.	.	.
.	.	.	.
$H\infty$	3,651	3.648×10^{-5}	$2 + \infty$

In addition to this so-called "Balmer series" of lines, hydrogen emits several other series of lines of shorter and longer wave lengths. These other series are named for their discoverers, Lyman, Paschen, Brackett, Pfundt, etc.

The wave lengths of the lines in any of these series can be computed by the use of the equation:

$$\lambda_H = \frac{R}{1/n^2 - 1/p^2} \text{cm.}$$

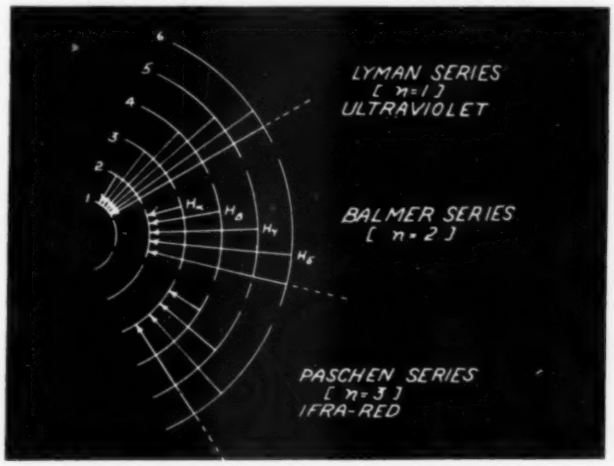
R is Balmer's constant, 9.17×10^{-6} cm. The n in this equation is equal to 1 for the Lyman series, 2 for the Balmer series, 3 for the Paschen series.

FIGURE 1—*Balmer Series of Hydrogen.*

the smallest p is $n + 1$, and increases in whole figure steps towards $n + \infty$. (See Problem 1). The Balmer Series of most elements was investigated first, because it is partly in the visible range and, therefore, easy to study. The Lyman series is in the ultra-violet (invisible) range of wave lengths, while the Paschen series is found in the also invisible infrared range. (Fig. 2).

The whole spectrum of radiant energy may be divided as shown in Table II. (See problem 2).

FIGURE 2—*Energy levels in the hydrogen atom,* corresponding to spectral lines emitted when the electron pulls back from a certain level (p) to a certain other level (n).



Balmer's empirical equation can also be applied in general for the removal of the last electron of atoms other than hydrogen if the atomic number (Z) is introduced:

$$\lambda = \frac{R}{Z^2} \frac{1}{1/n^2 - 1/p^2} \text{ cm.}$$

The spectra of these "hydrogen-like ions" lend themselves for such computations (See Table III and Problem 3).

TABLE III
First member of Lyman series for hydrogen-like ions

First step in the reaction	*Observed* *A*	*Computed* $\lambda = \frac{R}{Z^2}\left(\frac{1}{1/n^2 - 1/p^2}\right)$ cm.
$H \rightarrow H^+$	1215.663	1.216×10^{-5}
$He^+ \rightarrow He^{++}$	303.777	3.039×10^{-6}
$Li^{++} \rightarrow Li^{+++}$	134.993	1.351×10^{-6}
$Be^{+++} \rightarrow Be^{++++}$	75.923	7.60×10^{-7}

Once the regularities in the distribution of the spectral lines had been observed, interest in a "model" of the atom was aroused, a model which should illustrate the mechanics of the emission and absorption of only certain wave lengths. Niels Bohr formulated the theory of such a model. Its main points are:

1. Of the infinite number of orbits of an electron about the nucleus (possible according to the classical Newtonian mechanics) only a certain number actually occur. No radiation is emitted while the electron is in one of these orbits.

2. Radiation (energy) is emitted when the electron falls from a level of higher energy to a level of lower energy. Conversely, energy is absorbed when an electron changes from a lower level to a higher level. Such a change is called a "quantum jump."

3. The n and p values in Balmer's equation indicate the levels from which and to which the electron changes. Fig. 2 represents graphically some of the possible quantum jumps from levels of higher energy to levels of lower energies, corresponding to various lines in the emission spectrum of hydrogen.

Bohr's theory is based upon the assumption that not just any quantity of energy can be absorbed or emitted by an atom, but only certain quantities of energy, multiples of a minimum quantity of energy.

This concept of a "granular" (atomic) structure of energy has been concluded by Planck from certain radiation phenomena. Planck expressed the energy E (ergs) of radiation as its frequency ν (number of oscillations per second) times a constant factor h (6.55×10^{-27} erg $\times$ sec.). This equation

$$E \text{ (erg)} = b \text{ (erg} \times \text{sec.) } \nu \text{ sec.}^{-1})$$

is called Planck's equation or the fundamental equation of quantum theory. Since all waves of light show the same velocity c (3×10^{10}cm. $\times$ sec.$^{-1}$), the frequency ν, is related to the wave length by the equation:

TABLE II
Division of the Spectrum

Hertzian (radio) Waves	*Infrared Waves*	*Visible Waves*	*Ultra-Violet Waves*	*X-Rays*	*γ-Rays*	*Cosmic Waves*
from 10^{+5} to 10^{-1} cm.	from 10^{-1} to 8×10^{-5} cm.	from 8×10^{-5} to 4×10^{-5} cm. (8,000 — 4,000 Å)	from 4×10^{-5} to 5×10^{-6} cm. 4,000 — 500 Å	from 5×10^{-6} to 1×10^{-8} cm.	from 1×10^{-8} to 1×10^{-9} cm.	from 1×10^{-9} to 1×10^{-10} cm.

$$\nu = \frac{c}{\lambda}$$

Inserting this expression into Planck's equation we receive $E = h\nu = \frac{hc}{\lambda}$. This enables us to compute the energy corresponding to any quantum jump of an electron from the wave length of the radiation emitted or absorbed by the jump. (See problems 4 and 5).

To summarize these considerations, it can be said that the meaning of spectra is the energy uptake (or loss) per single atom. In general, all chemistry is interested in energy losses or gains during chemical reaction. If Planck's and Bohr's concepts are well founded, the spectroscopically observed energies must correlate with the energies observed in the "test tube" during chemical reactions. Consider, for instance, the Lyman series of hydrogen: Each spectral line of this series corresponds to one step in the removal of the electron towards infinity. The line H_∞ Lyman, therefore, should correspond to the energy necessary to ionize a hydrogen atom. It can be symbolized by the equation:

$$H + \text{energy} = H^+.$$

The energy necessary to ionize one gram atomic weight, and also for the conversion of all other metals into their ions, has been determined calorimetrically. These "heats of ionization" are given in Table IV.

TABLE IV
Energy of Ionization

Element	$\lambda\infty$ *(Lyman)* $A = 10^{-8}$cm.	V *Voltage of Ionization (Volts)*	U_o *Heat of ionization (Kcal. per G. At. Wt.)*
H	918	13.45	309
Na	2413	5.13	117.5
Hg	1188	10.38	239

The heats of ionization were determined per gram atomic weight, in other words "Avogadro's number" of atoms was in consideration, while the spectroscopical determination observes the energy changes of one individual atom. The heats of ionization, however, can be converted into ergs per atom by the use of the equation:

$$E = \frac{U_o}{N} f$$

Where f is the conversion factor from calories to ergs (4.168×10^{-7}), N being Avogadro's number (6.03×10^{-23}).

A third method of determination of the energy of ionization has been developed mainly by James Franck. The apparatus used for this determination is sketched in Fig. 3. The filament P, the screen S and the plate P are placed in an evacuated glass tube. The filament F is then heated like the filament in an electric bulb by an electric current. Like all glowing metals, F then sends out electrons. Between the filament F and the screen a variable electric potential V_1 is maintained through a battery, making S the positive side and, therefore, attracting the electrons emitted from F. While trying to reach the wire (forming the screen S) most electrons shoot through the loops of the screen, reaching the plate P instead. Passing through the galvanometer towards the ground these electrons produce a deflection of the galvanometer needle G. P is then made electro negative and, therefore, repels the electrons now coming on against the potential V_2. Choosing a suitable value of V_2 brings the needle of the galvanometer back to zero. A trace of gas, for instance mercury vapor, is next admitted into the evacuated tube and distributes itself between F and P. The electrons flying in this space collide with the atoms of the gas. The potential V_1 is then gradually increased and electrons now hit the plate P, as is indicated by a deflection of the galvanometer. However, when V_1 reaches a certain "critical" value, the galvanometer drops back to zero. From this it is concluded that certain electrical energies are "absorbed" by the vapor. Electrical potentials (volts) can be converted into ergs by the equation:

$$E = \frac{Ve}{f_1}$$

where f_1 is the conversion factor 300 and e is the electronic charge 4.77×10^{-10} erg.

The energetic values of the critical potentials correspond closely to the energetic values found in form of the wave lengths of the spectral lines and the heats of ionization. Fig. 4 shows the values of the potential V_1 plotted against the galvanometer deflection (amperes) for mer-

(Continued on Page 65)

FIGURE 3—*Schematic representation of James Franck's apparatus* for the ionization of vapors.

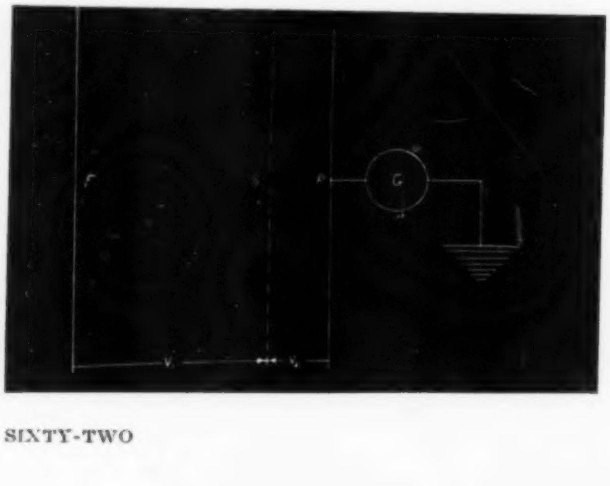
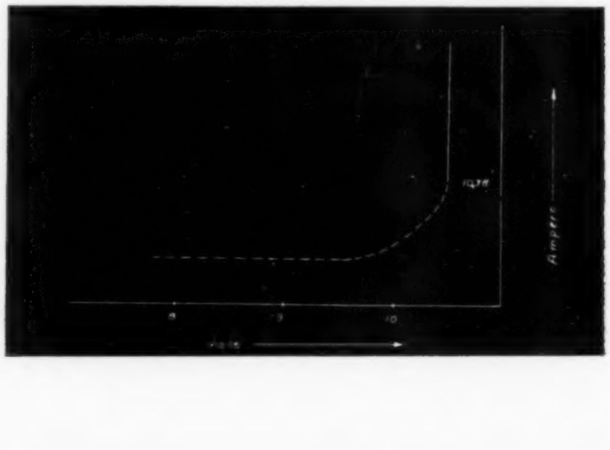


FIGURE 4—*The Ionization potential of mercury.*



NEW BOOKS

Interpreting Science Series

• *By* FRANKLIN B. CARROLL, Head, Science Department, Frankford High School, Philadelphia. Philadelphia: The John C. Winston Co. 1947.
Book I. Understanding Our Environment, Pp. 324, $2.00.
Book II. Understanding Our World, Pp. 426, $2.24.
Book III. Understanding the Universe, Pp. 568, $2.48.

Teachers seeking improved texts in general science should examine this new series with considerable care. Adapted to grades 7, 8, and 9, these books are attractive in format, content, and plan of instruction. The series is so well written that there should be little question of either teacher or student acceptance.

The author, who is a distinguished teacher in the field, has taken pains to keep procedures and terminology simple. Only inexpensive apparatus is required. Tested vocabularies are used. Throughout, the unity of science is emphasized, not its divisions. The repetition of units in succeeding volumes provides for a continuing study in certain fields and an adjustment of the difficulty of the material to the grade level. A unit on Water, for example, is found in all three volumes. Health is studied in books I and II; Air in I and III, and Weather in II and III. The richness of material allows a desirable flexibility in assignments. There is provision for individual differences and for testing.

Bright bindings, a two-column page, and many line drawings and photographic illustrations, some in color, add to the attractiveness of these books.

H.C.M.

Modern Cosmeticology

• *By* RALPH G. HARRY *and* P. B. MUMFORD. Third Revised Edition. Brooklyn, N. Y.: Chemical Publishing Co., Inc. 1947. Pp. XV + 515. $12.00.

This newly revised edition is a valuable reference book for the medical profession, especially the dermatologist, and also for the cosmetician, pharmacist and manufacturer.

The formulae and methods of manufacture of a wide variety of cosmetic and toilet preparations are supplemented by a discussion of the physiology and histology of the skin, nail, hair and teeth. The list of preparations includes creams, lotions, skin "foods," powders, sun-tan preparations, deodorants, depilatories, mouthwashes, dental preparations, shampoos, hair dyes, permanent wave preparations, hair tonics, eye lotions, nail and manicure products, insect bite remedies, and many others. The chemical examination of these products, the coloring of cosmetics, and the application of cosmetics, are also discussed. The value of this book is enhanced by photomicrographs both in black and white and color, numerous references to the literature, and a group of tables of especial value to a manufacturer.

Joseph A. Zapotocky.

Introduction to Human Physiology

• *By* W. D. ZOETHOUT. St. Louis: The C. V. Mosby Company. 1948. Pp. 424. $4.00.

This book is an excellent text for the introductory physiology course since it is well written and represents an adequate treatment for the beginning student. Teachers familiar with the more advanced treatise by Zoethout and Tuttle will find that the anatomical background of physiology has been de-emphasized, although sufficient anatomy has been included to make plain the processes under discussion.

The use of study questions at the end of the chapters helps the student to grasp the significance of the discussion and stimulates further thought.

The usual pitfalls of writing a simplified text of physiology, that of oversimplification and a tendency to lean toward the direction of a text in hygiene, are avoided. This book may be recommended for an introductory course in physiology or a survey course. It will not replace the more advanced books on physiology, nor was it intended to do so.

Alfred Halpern.

The Dissection of the Cat

• *By* BRUCE M. HARRISON. St. Louis: The C. V. Mosby Company. 1948. Pp. 109. $3.50.

This is a laboratory manual that incorporates much to be desired in books of this sort. There are many outline drawings to be completed by the student. These drawings are numbered to agree with the corresponding discussions. Also included in the discussions are underlined terms to be used in labeling the outline drawings. The drawings may be removed from the manual.

The text discussions and directions are clearly and simply written enabling the student to follow the experiments readily.

Alfred Halpern.

Bacteriology Laboratory Directions for Pharmacy Students

• *By* MILAN NOVAK *and* ESTHER MEYER. Second Edition. St. Louis: C. V. Mosby Co. 1947. Pp. 247. $2.75.

This loose-leaf, plastic-hinged manual contains 36 carefully described experiments chosen to fit the needs of students of pharmacy but suited to students in related fields. Early exercises in fundamental techniques lead into the study and examination of pathogenic bacteria. The bacteriological examination of water and milk, the measurement of the relative efficiency of antiseptics in vitro, sterility tests, antibiotics, and related topics are considered.

This is an excellent text for a full year's course which includes at least three hours of laboratory work a week. Some of the experiments are arranged for groups of students, a procedure some teachers may question.

P. F. Belcastro

Nature Quests and Quizzes

• *By* Raymond Tifft Fuller. New York: The John Day Co. 1948. Pp. 64. $1.50.

This attractive little volume is sub-titled "a nature-seeker's handbook". Buy it and become an adventurer at your leisure. The book lists 100 "quests" each of which is a nature adventure or problem that can be undertaken at the reader's convenience. Months or even years may be required to complete them all. The tasks include finding a hummingbird's nest, capturing and studying a glowworm, identifying four kinds of mice, telling the age of a tree, locating five stars and five constellations, capturing a bat in daytime, watching a robin make her nest, locating a bee tree, and dozens of others of similar nature. Nature study is made a game by assigning to each quest a numerical rating based on its rarity or difficulty. The author usually tells how to go about solving each problem, and indicates the best time of year for its successful completion. He adds interest and fun by including 100 nature questions, furnishing the answers in such a way that peeking is discouraged.

H. C. M.

Laboratory Experiments in Physiology

• *By* W. D. Zoethout. St. Louis: The C. V. Mosby Company. 1948. Pp. 263. $3.00

This is the fourth edition of this admirable laboratory text in physiology. The generous use of photographs and drawings of the equipment and operative setups allows the student to grasp the technique of the experiment and to work at his own speed. This book will serve well its purpose as a laboratory text. It is a worthy book of reference for the physiology laboratory.

The directions are simply and clearly worded. Study questions are provided to indicate the significance of the experiment.

Alfred Halpern

Physiology of Exercise

• *By* L. E. Morehouse *and* A. T. Miller. St. Louis: The C. V. Mosby Co. 1948. Pp. 353. $4.75.

This book is a novel treatment of the physiology of exercise in that man is the subject of most of the experiments cited. The text includes a complete study of muscle physiology in all its ramifications. Only an elementary knowledge of some of the basic principles of chemistry and physics has been assumed on the part of the reader. The more technical terms are adequately defined at the time of usage. A glossary is appended.

The book is written in a simple easy-to-read style and can be used to advantage as a supplementary text in the general course of physiology.

Alfred Halpern

★ ★ ★ ★ ★

"Wise men have always looked in amazement at the wonderful orderliness of nature and then recognized their own ignorance and have been content to stand in silence and reverence before Him repeating with the psalmist: 'The fool hath said in his heart, there is no God'."

Robert A. Millikan
The American Digest

To Serve Abroad

A quotation:

> "We have learned certain lessons from this war. We need thoroughness and accuracy. We need some substitute for war as a basis for providing a maturing experience, for exploration and for adventure. We must eliminate illiteracy. We must teach all children to read and to think independently. We must give them a thorough knowledge of the fundamentals of science and mathematics. We need a health and physical fitness program. We need a new spirit, a new love of our country. We need to indoctrinate our youth with the American way of life, but let us continue our educational program under the jurisdiction of the schools and colleges of America, public and non-public, in the decentralized fashion which has characterized our country for 300 years. We need no ministry of education. We need no super state departments. We need leadership, scholarship, research and planning at the state level. We need leadership and coordination at the national level. There is a challenge in the armed services program for civilian education."

Dr. Alonzo Grace made these trenchant statements in the article which begins on page 54 of this issue. We call especial attention to them because Dr. Grace has just resigned his position as Commissioner of Education of Connecticut to become Director of Education and Cultural Affairs in Germany.

He writes:

> *"After ten years of leadership in our State, it was with great difficulty that I made this decision, but as I have said so often, in these days when foreign ideologies continue to threaten the peace of the world, personal security becomes of much less importance than the general welfare. It seemed to me, after seeing the devastation in Germany not only to the material but to the spiritual, at least the next two or three years of my life should be dedicated to this program. I hope the frustrations which I know I shall encounter will not disillusion me, and I solicit the help of* The Science Counselor *and all other effective media of public opinion in our country. We need your support both in having educators and citizens understand the program, and also in becoming acquainted with the policies."*

This clear-thinking educator will carry with him to Germany the cordial good wishes of the Editor and of the many readers of this journal who know the distressing situation in Germany today. We have confidence in his leadership. Later, we hope to have Dr. Grace tell us something of his experiences in the new field.

H. C. M.

Atomic Concept of Energy

(Continued from Page 62)

cury vapor. The steep increase at 10.38 volt corresponds to the removal of the first electron of mercury, in other words, the ionization of mercury. Similar experiments on other elements gave the voltages shown in Table IV. (See problem 7).

The observations and determinations outlined here give an account of some of the phenomena observed in the simplest absorption and emission spectra. Essentially only one single electron has been in consideration, while heavier elements have several scores of planetary electrons and compounds composed of several different atoms, all possess planetary electrons. A considerable body of knowledge has been assembled and applied for the interpretation and prediction of such data. These techniques are known as quantum and wave mechanics.

These subjects have not even been touched in the preceding pages. It should be pointed out that in all of the problems mentioned the planetary electrons only are under consideration, in other words, the "atmosphere" around the center of the atom. The study of the atomic nucleus is a still more advanced discipline of human knowledge. ●

Problems

1. Compute the following wave length of hydrogen lines;
   a) H α Balmer *b*) H α Lyman
   c) H ∞ Balmer *d*) H ∞ Paschen
2. What is the essential difference between X-rays and visible light?
3. Compute the shortest possible wave length that can be emitted by:
   a) the hydrogen atom; *b*) the lithium atom.
4. What energy change takes place in an atom when it emits the wave
   a) 1895 Å
   b) 6.343×10^{-5} cm.
   c) 3.29×10^{-14} sec.$^{-1}$
   d) Find whether the above three waves are of the visible, ultraviolet, or infrared range.
5. Use the data given in Table IV to convert the wave lengths of the Lyman Series limits into ergs per atom.
6. Use the data given in Table IV to convert the heats of ionization into ergs per atom.
7. Use the data given in Table IV to convert the voltages of ionization into ergs per atom.
8. The wave length of a certain line in the Balmer series emitted by hydrogen is observed to be 3,891 Å. Compute from which orbit to which other orbit the electron has to jump.
9. *a*) What total amount of energy in calories is required to shift all the electrons in a gram atomic weight of hydrogen from the first Bohr orbit to the second Bohr orbit?
   b) What fraction of the energy of ionization is the above energy?

Table of Constants

Angstrom unit: Å $= 10^{-8}$ cm.
Balmer's constant: R $= 9.17 \times 10^{-6}$ cm. $= 9.17 \times 10^{2}$ Å
Planck's constant: $h = 6.55 \times 10^{-2}$ erg. x sec.
Velocity of light: $c = 3 \times 10^{10}$ cm. x sec^{-1}
Heat of ionization: $U_o =$ cal. x G.At.Wt.$^{-1}$
Calorie: 1 cal. $= 4.168 \times 10^{7}$ erg.
(1000 cal. = 1 Kcal.)
Avogadro's number: N $= 6.03 \times 10^{23}$ atoms per G.At.Wt.
Electronic charge: $e = 4.77 \times 10^{-10}$ erg.

Answers to Problems

1. *a*) 6.56×10^{-5} cm. *b*) 1.22×10^{-5} cm.
   c) 3.65×10^{-5} cm. *d*) 8.22×10^{-5} cm.
2. The wave length.
3. *a*) R cm. *b*) 1.01×10^{-6} cm.
4. *a*) 1.04×10^{-11} *erg.* *b*) 3.10×10^{-12} erg.
   c) 2.15×10^{-12} erg.
   d) ultraviolet, visible, infrared.
5. 2.16×10^{-11}, 8.12×10^{-12}, 1.64×10^{-11} ergs.
6. $2.14 \times 10^{11-}$, 8.12×10^{-12}, 1.65×10^{-11} ergs.
7. 2.14×10^{-11}, 8.15×10^{-12}, 1.65×10^{-11} ergs.
8. from 8th orbit to 2nd.
9. *a*) 2.34×10^{5} cal. *b*) ¾.

Acknowledgment

Thanks are due to Miss Virginia Bueche, Marygrove College, for her work on the problems, and the drawing of the figures.

★ ★ ★ ★ ★

A New Award

C. F. Fisher, president of the Fisher Scientific Company and of Eimer and Amend, has offered to finance an award to recognize and encourage outstanding contributions to analytical chemistry. The Board of Directors of the American Chemical Society has accepted administrative responsibility.

The first award will be made at the annual fall meeting of the A. C. S. in September, 1948. The award consists of a $1000 prize and an original etching to symbolize the award.

A Canvassing Committee consisting of C. M. Alter, chairman, G. E. F. Lundell, and M. G. Mellon is to make a selection of possible award winners; then the final selection will be made by an anonymous committee.

The rules for the award contain the following four statements:

1. *Purpose.* To recognize and encourage outstanding contributions to the science of analytical chemistry, pure or applied, carried out in the United States or Canada.

2. *Nature.* The award consists of $1000 and an original etching. An additional allowance of not more than $150 is provided for actual traveling expenses to the meeting at which the award will be presented.

3. *Rules of Eligibility.* A nominee must be a resident of the United States or Canada and must have made an outstanding contribution to analytical chemistry. Special consideration will be given to the independence of thought and the originality shown, or to the importance of the work when applied to public welfare, economics, or the needs and desires of humanity.

4. *Award Lecture.* The recipient of the Fisher Award may be asked by the Award Committee to deliver a paper or lecture upon the subject of his scientific work at the time the award is presented.●

★ ★ ★ ★ ★

"If we want to help save the world within the next few years, we must attend to the education of adults, for only they will have the influence within that period to affect the course of events."

Robert M. Hutchins
The Educational Record

Let the MASTER MAGNET

Show Your Class . . .

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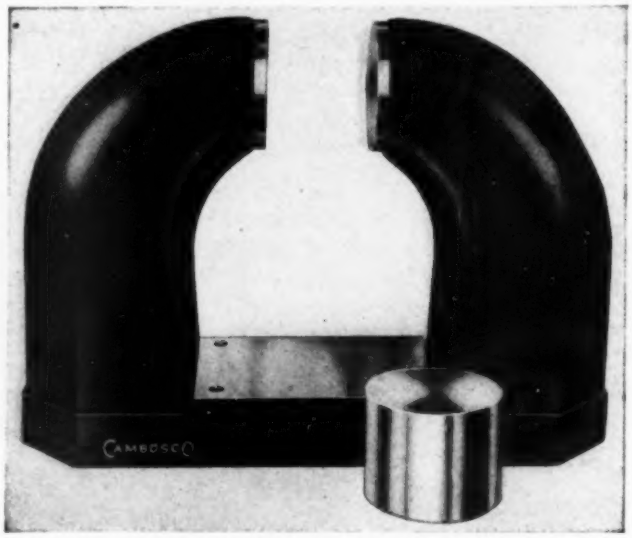
- **Magnetic Induction,** on a heroic scale, with iron filings, soft iron rods, paper clips, etc.;
- **Evidence of Lines of Force,** in filing patterns that really look like the text book diagrams;
- **"Elasticity" of Force Lines,** in the form of filing "fibers" which can actually be "stretched" with the finger;
- **Electro-Magnetic Induction** with any coil —even a single loop—of wire held near the poles of the Master Magnet;
- **Magnetic Damping,** and the magnetic brake, consequent upon eddy currents in non-magnetic conductors.



The amazing Master Magnet—originally developed for the Army Air Forces, as a radar component—now brings to your lecture table means for fascinating demonstrations throughout the topic of Magnetism.

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The Master Magnets here offered are neither second-hand, nor reconditioned. Their manufacture was completed too late for the intended application. Each magnet is brand new, and in perfect condition—exactly as specified by Uncle Sam. But the price represents a discount of more than 75% from the Government cost. Dimensions, 2½ x 5½ x 7½ in. Weight, 13½ lbs.

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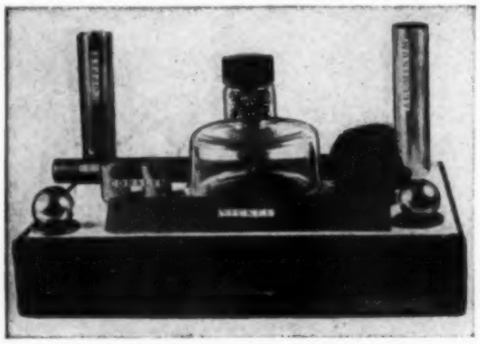

Typical Demonstrations

Fig. 1

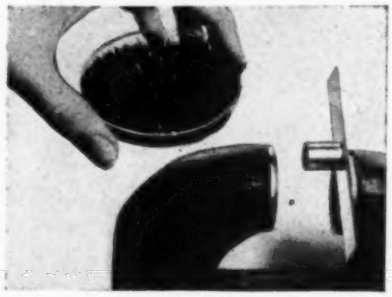

Fig. 2

•The MAGNETIKIT

This handy kit of accessories for lecture demonstrations in Magnetism includes the following materials:

1 Selected Specimen of Magnetite; 1 Strip of Pure Nickel, 19x125mm; 1 Rod of Soft Iron, 8x150mm; 2 Soft Iron Rings, 21mm; 2 Cylinders of Pure Cobalt, about 13x18mm; 2 Steel Balls, 19mm; 100 Steel Balls, 5mm; 1 each Cylinders of Aluminum and Copper, 19x75mm, drilled for suspension; and 1 Sealed Transparent Container with Fine Iron Filings. With instructions for use.

No. 59-195 In partitioned box $3.65

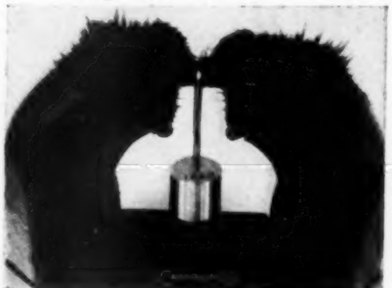

Fig. 3

Fig. 4

• Fig. 1—Ordinary paper clips demonstrate magnetic induction. • Fig. 2—At left, iron filings; at right, cobalt cylinder and nickel strip. • Fig. 3—Mass of 100g supported by iron filing "fibers." • Fig. 4—Swinging aluminum cylinder damped by eddy currents.

CAMBOSCO SCIENTIFIC COMPANY

3739 ANTWERP STREET ● BRIGHTON STATION ● BOSTON, MASS.

The G. I. Way

(Continued from Page 56)

(5) Are we dodging the issue by maintaining that a fundamental goal of education is self-discipline, as distinguished from discipline in the military sense and as practised in American schools in the past? Can self-discipline be developed without leadership and direction? Can we develop self-discipline without having had the opportunity to learn by experiencing freedom?

(6) Shall we determine the educational maturity of individuals on the basis of semesters, credits, course requirements, and prerequisites, or shall we soon begin to disregard these irrelevant organizational factors and provide for the measurement of learning through tests of achievement, social competency and cultural development?

(7) Shall we be able to organize courses or areas of learning around specific objectives which the classroom leader understands and toward the attainment of which he directs his leadership; or shall we continue our basic development on certain cardinal principles?

(8) Shall we adopt training aids universally without critical judgment, or shall these aids to learning definitely be incorporated in the course of study or in the area to be taught?

(9) Shall we insure maximum learning in the minimum time by the re-appraisal and re-evaluation of course content, or shall each department be an empire unto itself, expanding courses quite irrespective of the merit of the content contained therein or its contribution to the attainment of the common objectives?

(10) Shall individuals with special talent continue to be denied access to further education because of the financial inability of parents, or has our country an obligation to provide equal access to educational opportunity and to underwrite through scholarship aid, talent that otherwise would be lost?

(11) Shall we have longer school days, with interesting schedules for all and with the present system of homework organized under competent leadership as part of the program, or shall we continue to believe in schedules for faculty, parent and community convenience?

(12) Will we recognize incidental learning as being as important as formalized learning within the classroom? Shall we recognize the ingenuity of the individual in acquiring knowledge, habits and attitudes acceptable to the standards of the school or college, but quite outside the jurisdiction of the institution?

Perhaps thus far we have given lip service to this phase of the education program. On the other hand, we should not ignore the area of individual similarities. For example, we all purchase goods at the corner grocery store irrespective of our intelligence quotient, sex, age group, or probable learning rate. The right of suffrage is not determined on the basis of individual differences.

We have learned certain lessons from this war. We need thoroughness and accuracy. We need some substitute for war as a basis for providing a maturing experience, for exploration and for adventure. We must eliminate illiteracy. We must teach all children to read and to think independently. We must give them a thorough knowledge of the fundamentals of science and mathematics. We need a health and physical fitness program. We need a new spirit, a new love of our country. We need to indoctrinate our youth with the American way of life, but let us continue our educational program under the jurisdiction of the schools and colleges of America, public and non-public, in the decentralized fashion which has characterized our country for 300 years. We need no ministry of education. We need no super state departments. We need leadership, scholarship, research and planning at the state level. We need leadership and coordination at the national level. There is a challenge in the armed services program for civilian education. ●

Elementary School Science

(Continued from Page 53)

learns of the energy the Creator placed in the universe and how He has planned that this energy be made available to serve man's needs. By learning about the kinds of energy and their transformation the child understands the blessing of the gift of power as used in machines. He learns the economy of work.

The child relates his study of machines to the various trends in history. He learns how one age of man's life develops into another because of new discoveries of natural laws and their applications by inventors. He learns of the uses of machines to mankind and the social problems they produce. He learns that poverty and other problems are prevalent in this world when progress in the practice of Christian social living by men lags behind progress in science.

A working knowledge of scientific things enables the growing youth to play a more intelligent role in the affairs of his daily life. It helps him to appreciate the scientific inheritance of the past which makes modern life what it is today. He learns that scientific progress is faster today than in earlier times by very reason of this inheritance, the work and sacrifice of heroic men and women of the past. He is stimulated to discover things for himself and become a leader in the science of tomorrow so that the present pace of scientific progress will continue.

In a good course in science the child learns that the earth was created by God. "The earth is the Lord's and the fulness thereof." He learns that man was created to be the ruler of the earth for it was made to serve his needs. He learns that the earth is full of rich treasures and that there are enough material things for all if man develops a conscience for using them according to his needs, not according to his desire for wealth.

An elementary science course includes an enriched study of conservation of natural resources. A study of conservation, of the interdependence of plants, animals and man, shows the child how balance of resources is maintained by God's laws in nature. He learns that man holds all things in stewardship and should replace the things of earth that he uses so that future generations will have their just inheritance. The child sees that, if we waste natural resources or allow them to be heedlessly destroyed, we not only harm ourselves but also rob others of what justly belongs to them. Man's work is to be a builder, not a destroyer.

There would be few conservation problems if man developed habits and attitudes of responsibility toward the gifts of nature. A study of science helps children realize the necessity of sharing in justice and charity the fulness of the earth with less fortunate people. It is lack of this realization that developed the situation in the world today where more than one-half the Europeans, three-fourths of the Asiatics and great numbers of both North and South Americans are underfed. Lack of balance and conservation in agriculture, manufacturing and transportation is adding millions to the starvation lists of the world each year.

A rounded program in elementary science includes a study of the laws of health, safety and physical education. Scientific knowledge ministers to the preservation of health and safety, and to the stimulation of physical growth. Without these assets the child cannot achieve economic competence in the world in which he must make a living. Habits of health and safety are also necessary for social adjustment.

Materials for elementary science are in abundance these days. There are films and filmstrips on various grade levels. Many of these are free or inexpensive. With a wise choice from these films, a more effective program can be conducted. The need for visual aids in the presentation of scientific truth is vital. Understanding of subject matter is necessary if the course is to accomplish one of its main objectives, the laying of a foundation for interpreting things of science and enjoying scientific reading. There are many excellent books about nature and science written in a style that is charming to children.

Good teaching stimulates self-activity. Sometimes this activity involves mechanical skills. With the aid of low-cost tool chests a child can set up a workshop of his own where he can spend many happy hours during his evenings and vacation days trying out things he likes to do. Free and inexpensive materials are available in the form of projects, charts, exhibits, pamphlets and work manuals for all the members of a class. They stimulate enjoyable scientific group activity.

Science lessons in the grade school include group experiments, demonstrations, talks by experts in the various fields of science, reports, and hobby projects. These stimulate discussions and observations, the weighing of facts and the solving of problems. Elementary exercises lead to the techniques of classification of materials, the proper filing of data, the use of the scientific method. A thorough science course in elementary and junior high school helps the boy and girl to discover possible talent in some field of science and perhaps to choose the area in which he likes to work. Thus a problem in personal and vocational guidance may have been solved.

In summary, we may say that a science program helps boys and girls to find and adjust themselves to life in a scientific world. There is a place in the business world of today for every boy and girl who has talent in science. Intelligent youth are needed in the professions, in laboratories, in research centers, in factories, in salesrooms where a knowledge of science and a scientific attitude enable a person to make a living by serving his fellowman.

The contribution of such a program to the child's balanced living justifies the time spent on it in a Catholic school. The realization that under God he is a steward of his Master's goods on earth gives more meaning to the child's personal dignity and, consequently, to his powers of performance. ●

Light Wave of Mercury

(Continued from Page 51)

nearly equal intensity. This pair of yellow mercury lines produces interference coincidences at intervals of 275 waves, and is happily heuristic for the whole order of interference without counting any fringes; it has no convenient counterpart in cadmium.

Mercury is the only heavy stable element that has an appreciable vapor pressure below zero degrees Centigrade, and therefore is unique among all elements in radiating, at low pressure and temperature, a relatively simple spectrum of extremely sharp lines provided isotopic structure is eliminated. The green line of mercury, rejected by Michelson 55 years ago on account of complex structure, has finally, by the production of mercury 198, been freed of its seven-isotope curse, and the green line of Hg^{198} now stands alone as the most nearly ideal standard wavelength that can ever be obtained from any atoms, natural or artificial. Coupled with the fact that adequate quantities of absolutely pure Hg^{198} are now obtainable by neutron bombardment of gold in chain-reacting piles, the unique properties of Hg^{198} force the conclusion that a progressive scientific world will eventually adopt the wavelength of green radiation (5461 A) from Hg^{198} as the ultimate standard of length.

DR. WILLIAM F. MEGGERS is positioning an electrodeless lamp containing mercury isotope 198 for an accurate determination of wavelength of the green radiation from the mercury relative to the red radiation from the cadmium lamp (right). The Hg^{198} lamp is operated with radio waves of 110 megacycle frequency, and the Cd lamp by 60-cycle alternating current. These investigations prove that radiations from mercury 198 are much more monochromatic than any other atomic radiation, and mercury 198 therefore provides a wavelength of light which may serve as the ultimate standard of length.

The meter unit, the present unit of length, was created about 1790 to represent one-ten millionth of the earth's quadrant. In 1827, some natural philosophers meeting in Paris agreed that the meter could not be reproduced if the form of the earth were changed by collision with a comet. A Frenchman, Jacques Babinet, then proposed a light wave in a vacuum as a natural unit of length independent of the earth's dimensions. Later, the same thought was expressed by German, Dutch, and British scientists, but the first practical results must be credited to Americans, A. A. Michelson and E. W. Morley, who, in 1887, outlined "A method of making the wavelength of sodium light the actual and practical standard of length." Their method, involving the use of the optical interferometer devised by them for their celebrated experiments on the relative motion of earth and ether, consisted of the measurement of a length and the counting of an equivalent number of interference fringes.

In 1889, Michelson and Morley described in detail a method of measuring the meter in light waves, and predicted that the brilliant mercury green line would in all probability be the wave to be used as the ultimate standard of length. Searching systematically for the radiation best suited as an ultimate standard, Michelson discovered in 1892, that the green light of mercury is complex, and discarded it in favor of the red light of cadmium. These classic investigations promptly led to Michelson's invitation to the International Bureau of Weights and Measures, where he performed his celebrated determination of the relation between the meter and the wavelength of cadmium red radiation. In the succeeding forty years Michelson's experiment was repeated a half-dozen times and his result has been amply

confirmed, considering the fact that the lines on the meter bar are ten to twelve wavelengths wide.

Indeed, it is the character of ruled lines themselves which limits the accuracy of wavelength-meter intercomparisons and there is therefore hardly any point to measuring the wavelengths of Hg^{198} lines relative to the meter. The wavelength of Hg^{198} green light can readily be measured relative to cadmium red light from ten to one hundred times more accurately than either relative to the meter. Adoption of the present provisional relations as exact, and subsequent substitution of Hg^{198} green for cadmium red appears to be the logical and expeditious approach to a better standard of length. ●

Chart Service

(Continued from Page 52)

tically waterproof. Enamel paint has proved the best medium for making the letters, drawings, and graph lines, since it will not crack as easily as poster paints when rolled, and is washable with just a damp cloth.

After the means of presentation and size of the chart have been decided upon, a layout of the final job is prepared. In order for a chart to serve its instructional purpose, it should have an attractive layout with balance of colors, darks and lights, and emphasis on the important points. A frequent error of instructors is trying to present too much on one chart. A chart becomes monotonous and confusing if there is too much lettering or too many diagrams presented upon it. Sometimes the amount of lettering can be reduced by placing the important headings and subheadings on the chart in a neat outline form, with the instructor adding the detailed information orally at the time of class presentation. This practice is helpful to the student and allows him to take a much better set of lecture notes. The confusion resulting from too many diagrams on one chart may be corrected by making a series of charts. This can usually be done without losing the unity of the subject matter.

The instructor ordering the chart may wish to see it in the roughed-in form before the permanent paints or inks are applied. At this time he can check to prevent mistakes in the rendition of technical material. He can also get an idea of how the finished product will look. Mistakes are easy to correct at this phase, since the larger charts requiring paints are blocked in with a very soft charcoal which can be removed by wiping with a dry cloth. After the chart has been approved, the finished letters and lines are applied, allowed to dry, and all block-in and guide lines removed.

The finished charts may be prepared for hanging in the classroom by inserting grommets at the top or by placing wood dowels or half-round pieces of wood at the top and bottom of the charts. The use of half-round pieces is the more desirable of the two methods, since they form a solid foundation for rolling the chart for storing, and also weight the bottom so that it will stay flat during its use in the classroom.

In its first year of operation, the Chart and Graph Service has completed more than one hundred major projects for forty departments, colleges, and services on the campus. In addition to work completed for classroom use, the Service has illustrated pamphlets, designed titles for motion pictures, and made posters promoting University activities. Some examples follow:

Large charts showing the venation of insect wings for the entomology department. These were made by enlarging the actual wings by projection in a 2" x 2" slide projector.

Illustrations of ancient Aztec and Mexican musical instruments made by line drawings from photographs, for the School of Music.

A series of large graphs with cartoons depicting egg, broiler, and roasting chicken production by states in the United States, for the poultry department.

A map on 30" x 40" illustration board with hinged, cutout overlays of seven glacial stages on the North American continent, for the department of geology.

Two panels, 17'-6" x 6'-8", on plywood, showing the electro-motive series of elements and a table of physical constants, for the lecture amphitheatre in the Chemistry Building.

These are just a few of the many charts, graphs, posters, maps, and special drawings the Service has produced to aid instructors in presenting academic subject matter to their students. ●

★ ★ ★ ★ ★

"The science teachers are the only people prepared to find and guide the young scientist. Let's give them time to do it."

James F. Sears
Evansville College
Time for Science Instruction, 1946

★ ★ ★ ★ ★

"Civilization can be saved only by a moral, intellectual, and spiritual revolution to match the scientific, technological and economic revolution in which we are now living. If American education can contribute a moral, intellectual, and spiritual revolution, then it offers a real hope of salvation to suffering humanity everywhere. If it cannot or will not contribute to this revolution, then it is irrelevant, and its fate is immaterial."

Robert M. Hutchins
The Educational Record

Girolamo Saccheri, S. J.

(Continued from Page 47)

straight line falling on two straight lines makes the interior angles on the same side less than two right angles, the two straight lines, if produced indefinitely, meet on that side on which are the angles less than two right angles."

This so-called parallel postulate found little favor with some of Euclid's distinguished followers. Apparently Euclid himself "did not regard this postulate as being quite so fundamental, or quite so self-evident (if we may use that expression) as his other postulates. For although he states it with the other postulates, he avoids using it until the twenty-ninth theorem of his first book."[17]

Unlike the preceding axioms which were in such close conformity with experience that they were regarded as self-evident abstractions or their direct consequences, the parallel postulate was complicated, not self-evident, and could not be shown to be the consequence of such axioms. The growing feeling of uncertainty over this postulate led some mathematicians to the view that since its validity could not be established, they were justified in replacing it by another, even by a contradictory postulate. From such a substitution could be developed a new geometry which would be self-consistent, independent of the parallel postulate, and non-Euclidean.

But that course would portend serious results; for on the parallel postulate rests the theorem that the sum of the interior angles of a triangle equals two right angles. Since the basal properties of trigonometry depend on this theorem, one can readily appreciate the mathematicians' concern about the parallel postulate, and Saccheri's zeal to establish its validity, and vindicate Euclid.

That is what Saccheri proposed to do in his *Euclides*. The geometrical construction he employed was a birectangular isosceles quadrilateral. Hence, two of the interior angles are given as right angles. Saccheri observed that the other two angles, being equal, are either right angles or not right angles. In the latter case they are either obtuse or acute. Thus he analyzed the problem into three hypotheses: (1) the right angle hypothesis, (2) the obtuse angle hypothesis and (3) the acute angle hypothesis. The first hypothesis would immediately affirm the parallel postulate; and Saccheri disposed of the second with the aid of the Euclidean assumption that "two points determine a straight line" and the Archimedean assumption that "every straight line besides being unbounded, divides the plane into two parts, is open, infinite."

But finding the third hypothesis quite formidable, Saccheri resolved, he says, "to leave no stone unturned" until he would "show the hostile hypothesis of the acute angle torn out by the very roots contradictory to itself"[18]. Finally, after a series of some of the most beautiful demonstrations in geometry, he thought he had so disposed of the acute angle hypothesis. But like every other geometer for a century after him, Saccheri employed the Archimedean and Euclidean assumptions that a straight line is of infinite length. "These assumptions nullify the possibility of a pair of obtuse angles in a birectangular isosceles quadrilateral, and to that extent prove the 'hypothesis of the right angle', which is equivalent to the Parallel Postulate. But they are no obstacles to this pair of angles being acute".[19] Had Saccheri realized this, he would have been forced by his own demonstrations to accept results far more important than he imagined. For the beautiful demonstrations which he drew forth from the acute angle hypothesis constituted the first non-Euclidean geometry, the precursor of the great geometries of Lobachevsky and Bolyai, the projective geometry of Cayley and Klein, and the elliptical geometry of Riemann. These have given us new mathematical spaces in which one, two, or no parallels can be drawn through a point in line; wherein the sum of the angles of a triangle is less than, equal to, or greater than two right angles; and where a straight line has one, two, or no real points at infinity.

A research by David Eugene Smith[20] shows that some of the constructions used by Saccheri date back to Omar Khayyâm. But Saccheri not only hints, as Dr. Smith remarks, "at a new type of geometry; whereas Omar Khayyâm seems not to have taken this step"; but Saccheri developed non-Euclidean geometry to such an ex-

tent in his *Euclides* that, in the words of Professor Corrado Segre, "the first seventy pages [apart from a few isolated phrases] up to *Proposition 32* inclusive, constitute an ensemble of logic and of geometric acumen which may be called perfect".[21] And Professor H. P. Manning in his textbook, *Non-Euclidean Geometry*, states: "It is his (Saccheri's) method of treatment that has been taken as the basis of the first chapter of this book".[22] •

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Photography for Teachers

A six weeks course in photography for teachers in secondary schools will be offered by the Department of Photographic Technology of the Rochester Institute of Technology beginning July 12th. The course will require 30 hours weekly and include (1) Theory of Photographic Processes, (2) Teaching Methods in Photography, and (3) Lectures on practical photography with work in the studio and laboratory. The projects have been arranged so as to provide teachers with material which may be used for teaching purposes in their own class or club activities. The course has been approved by the New York State Department of Education for in-service credit. For particulars write, Department of Photographic Technology, Rochester Institute of Technology, Rochester 8, New York. •

Criminalistics

(Continued from Page 44)

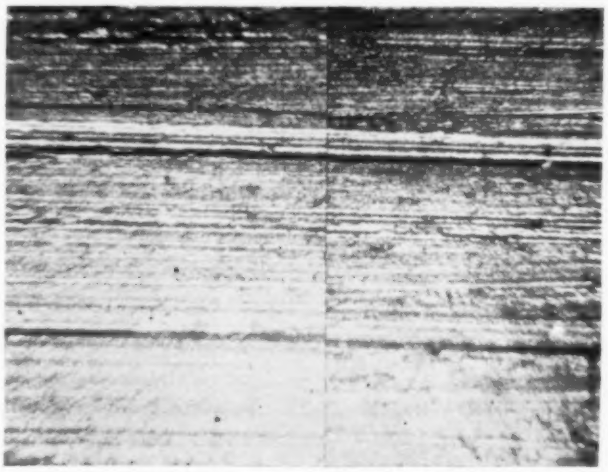
With regard to academic interest in police training, this writer feels that the profession of law enforcement is at a stage comparable to that of the medical and legal professions in their early history.

That police executives realize the value of training, is evidenced by the many fine "recruit" and "in-service" training programs now in operation in numerous police departments. Despite the fact that this type of training is being exploited to a high degree, one theme is found running through the plans and demands of these executives—the desire for increased pay commensurate with the importance of the police function, and professional recognition.

This writer has heard city government officials state that they are well aware of the importance of a police agency in the function of a municipal government and would gladly authorize remuneration on a professional scale if they were assured of professional performance. The employment of individuals specially trained for the police profession would aid materially in reaching this goal.

It has been objected that the teaching of police science on the academic level might be ill-advised in that "trade secrets" may be revealed. These same objections were raised at one time concerning the teaching of law and medicine; however, the record speaks for itself. One might add, parenthetically, that little or nothing is taught in a university that is not recorded in the literature.

The formal teaching of police science and administration is moving slowly forward. The Scientific Crime Detection Laboratory of Northwestern University was sold to the Chicago Police Department in 1935. The



"MATCH" OF RIFLING MARKS on two bullets indicating both were fired from the same gun.

University of Wichita, Kansas, operated a police training department in conjunction with the city police department, but, unfortunately, it was abandoned in the late 1930's. In 1935, a full four year course in Police Administration was inaugurated at Michigan State College. A nine month in-service training program is conducted by the Michigan State Police. The general program is now being enlarged. The University of California at Berkeley offers training in police administration and police science. Washington State College at Pullman, offers a four year course and graduate work in police science and administration. Harvard University Medical School has a department of Legal Medicine which offers training for those interested in medico-legal work. The University of Illinois has a department of Legal Medicine; the University of North Carolina, a department of Law Enforcement; the University of Iowa, a Bureau of Public Safety; the University of Indiana, an Institute of Criminal Law Administration; and Purdue University, an Institute of Public Safety: These are a few of the colleges and universities offering some type of training in the general field of public protection, in addition to courses in criminology, legal psychology, penology, etc.

The question of placement of graduates has been raised by some skeptics. True, many cities have civil service regulations or residence requirements which prevent all but local graduates from securing employment; however, in recent years the position of Chief of Police or Director of Public Safety has been placed on a competitive basis in several cities, open to any qualified applicant. Richmond, Virginia, Seattle, Washington, and Flint, Michigan follow this procedure. This type of thinking represents definite progress in establishing law enforcement as a career. The next step is to make similar concessions in the lower ranks, thus enabling municipalities to employ specially trained people for certain positions.

College and universities should not wait for municipal governments to create the demand for trained law enforcement officers. They might well follow the practice of business—produce the product, and then through public enlightenment create a demand for it. ●

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"Time is the essence of teaching by evidence-gathering, and evidence-gathering has in it the chief contribution of science to the education of the child."

Morris Meister
Time for Science Instruction, 1946
National Science Teachers Association

★ ★ ★ ★ ★

The so-called "scientific attitude" is useful in any and all walks of life. It seems to me to consist of three qualities, namely:

1. Being inquisitive—questioning not only what is known, but even more looking into the unknown and asking constantly *how*.

2. Being observant—This was one of the greatest attributes of Charles Darwin. He traveled widely, but few people if they were to take the same journeys would see as much as he saw.

3. Being critical—examining one's own data and those of others, to see what they mean. Without this quality, a person may possess information, but he is sure to lack vision."

Ruth M. Addoms
Duke University
Association of American Colleges *Bulletin*

Enlivening Science

(Continued from Page 42)

est in discovering the possible utility of current materials. And it was a further condition of the study that each of these experienced teachers should continue to teach their courses in science with the purposes and values in mind that hitherto had won their acceptance. The single new element to be introduced was increased employment of novel materials. And even with these, the extent of their utilization was left to the discretion of the instructors in charge.

Preceding the spring semester, 1946, all the teachers from the fifteen schools to be involved in the study assembled at Berkeley for a week of group discussion at which staff members of the Divisions of Audio-Visual and Secondary Education, California State Department of Education, were assisted by representatives of the Schools of Education of Stanford University and the University of California. There the teachers exchanged viewpoints, examined a profusion of magazines and films, and were assured of their complete liberty to exercise their own judgments as to their utilization of these. It was emphasized that nobody connected with the study approached it with preconceived ideas of traditional or progressive education and that the directors of the study had every confidence in the competence of experienced teachers to determine the degree to which current materials might usefully contribute to student achievement.

The science teachers whose reports are here summarized taught biology, chemistry, physics, and physical science, the last a survey course for juniors and seniors. The accompanying table gives school size and student enrollment in the sections of science classes participating in the study.

Numerous magazines were regularly used in classwork. At an evaluation workshop held at Stanford University upon the close of the spring semester, the twelve listed by teachers as most useful in the science classes were:

> *Collier's, Fortune, Hygeia, Life, National Geographic, Natural History, Newsweek, Popular Mechanics, Popular Science, Saturday Evening Post, Science Digest, Science Illustrated, Science News Letter,* and *Time.*

During that semester the publishers of *Time, Life,* and *Fortune* had generously made available without cost to the schools one copy of *Fortune* monthly per classroom, one of *Life* each week for every five students in a class, and a copy of *Time* for every student. *Time's* sections on Medicine and Science were avidly read. For bulletin board displays, pictorial matter from *Fortune, Life,* and the *National Geographic* proved particularly helpful.

The devices by which teachers stimulated their students to glean science facts regularly from current magazines is best illustrated by specific examples. At Bakersfield, in biology classes Axel Petersen placed on the blackboard questions based upon the Science and Medicine sections of the current issue of *Time.* His effort was to have students relate biology to other subjects. When an article on the Caesarian operation appeared, a student unearthed Shakespeare's reference to it by Macduff in Macbeth. An article on animal migration during the Ice Age was connected with the movements of peoples in prehistoric times.

Although Mrs. Helen Smeltzer at Pittsburg had no set day for students to report current events in science, she encouraged them to explore sidetracks in biology brought to their attention by the pages of magazines. Advertisements by a dairy corporation of ice cream, and by an air-freight carrier of unusual shipments, started a student theretofore uninterested in biology upon an intensive study of bacteria, pasteurization, and refrigeration. An advertisement by a pharmaceutical house afforded the initial impetus to a student to prepare a detailed report of immunization and vaccination. The Hiroshima report led a third to a study of heredity and sterility.

The anecdotal record kept by Mrs. Smeltzer for biology classes shows how students used periodicals as points of departure into class discussion. Typical entries are given.

"*February 13.* War Surgery article got mixed response. Rosalie refused to look at the pictures. Angie asked about plates in the skull. Agnes told about her uncle's experience with plastic surgery. Frances, whose father had been a physician, explained to the class about plastic surgery.

"*March 5.* Marilyn brought in collection of shells for mollusk study. Angie gave Italian recipe for squid and sea urchins. Class not aware they are so widely used as food. Lively discussion of food customs developed. Vincent told how Pittsburg fishermen go to Alaskan waters for salmon run. Discussion on effects of dams in rivers on commercial fishing. Showed film, 'Alaska's Silver Millions.'

"*March 25.* Gerald brought in tadpoles. Jack brought 14 toads. Discussion of superstitions about toads. Dorothy not convinced about warts; rest of class ridiculed her. Armida and the Gonzales girls asked Jack for some toads to put in their home gardens. Article on 'Snake Eats Rat' started discussion on snake stories. Edna volunteered to run down the truth about these. David collecting articles on snake venom and its uses. Arnold told how Boy Scouts take precaution against snake bite.

"*April 9.* Betty arranged bulletin board of pictures of unusual mammals around a large world map. *Life's* pictures of Australian animals had every one at the bulletin board. Elvira asked about the rats that were to have babies, whether they reproduced like cats and dogs. Armida asked whether all mammals reproduced alike. Dorothy asked about gestation periods of various mammals.

"*April 23. Time* articles on desperate food situations the world over soon had students telling about their relatives in Italy and sending food and clothing there. Students appalled at pictures of children suffering from

malnutrition. Classes working on diet tables and menus. Marilyn brought Camp Stoneman mess menu sheets. Jennie told about her father's ulcers and his diet."

Mrs. Anna Bigler found magazine articles a capital device to bring timid students actively into class discussions. Her Sequoia students adopted the slogan, "Better Living Through Science," and prepared bulletin board displays and detailed notebooks on American birds, cancer, cotton, and parasites—from mistletoe and Indian pipes to tapeworms and malarial protozoans.

Bulletins prepared by General Electric and Westinghouse and other firms were utilized by C. J. Roupe at Delano more than magazines, but a study of the chemistry of petroleum coincided with accounts of the oil fields of the Middle East and these were fully utilized. Stephan Coleman of Fortuna held a weekly "round-up" of science facts students had found in magazines and newspapers. Textbooks were used as references to verify statements in the press. He himself kept a class diary for the record.

Quotations from three days of the semester must suffice.

"*May 8.* Assembly speaker today, an engineer, talked on developments in electricity. In class afterward students remarked how much better able they were to understand and appreciate his talk than those who have not studied science. Several pointed out that their magazine readings and current science discussions had prepared them to follow the speaker when he talked of atomic energy, mesons, radar, and ultraviolet light.

"*May 10.* Showed physics class two films: 'Electronics at Work' and 'Music in the Sky.' Former film fine for uses of electronic tubes.

"*May 13.* Gave May current affairs test in physics again, eight questions on science and medicine. Nine students improved scores over previous test; seven got same score; and one a poorer score than at first of semester. General improvement in understanding indicated but no extraordinary improvement. However, four of the eight questions dealt with phases of science not covered in physics."

At Kearny Junior-Senior High School in San Diego, Miles Miller utilized magazines to stimulate students to build a science vocabulary. One day each week classwork was focused about current science articles and on another day an appropriate film was the basis of class study. "The magazines were used for *teaching*," he wrote in his final report. "Many times not on the precise topic in hand; at other times they gave *new* or *additional* information on some topic we had had or would have. Often the material in the magazines was an entity in itself. Sometimes the magazines served as a variation to add life to the class." Concerning the objectives of his classes he stated, "Science is not static and a thing apart but is woven intimately into all phases of our daily life. Additional funds of knowledge are to be found everywhere. The physics class this semester will use elec-

tricity and its applications for the background of the course; in chemistry sulfur, the halogens, nitrogen, carbon, and the metals will be the framework."

Each week he gave specific references to science news and posted words whose definitions would be needed to read them. From his account, readings posted for one week are given.

Current *Time*

Page 23	Back of the Barn
26	From Hiroshima
55	Color on the Air
60	Bombs on Ice
	How to Liquidate Heredity
	Stargazers
75	Defeat Early Blindness

Current *Life*

Page 22	Uses of Steel
30	Man Reaches the Moon
45	Dr. Ley's Brain
57	Streptomycin
69	Roadable Plane

Words: geneticists, hybrid, mutation, photomicrographs, Lysenko, high vacuum, cathode ray tube, nutrient, inoculate, anthropologist, sunspot.

At San Dieguito, the chemistry instructor persuaded the English teacher to permit her students to choose eminent chemists for the biographical sketches each was assigned to write that term. A *Fortune* article on Nitrogen introduced a study of its compounds and "gave meaning to the nitrogen cycle." Mrs. Charmion McMillan also collaborated with a colleague to develop jointly in United States history and chemistry classes a unit on the "Atomic Age." From a stenographic report of a class discussion reviewing the use of magazines and films, the following excerpt is quoted:

Mrs. McM. How have you liked using *Time*, *Life*, and *Fortune?*

Elizabeth. I would like to use either the textbook or the magazines, not both. When you have to study both it is hard, for the tests cover both.

Kay. We are trying to keep up with the other class which doesn't use magazines. Our textbook is designed for five days a week. Movies and reports take up a lot of time, too.

Mrs. McM. Do you feel you are working up to capacity? Are you putting your best into all your classes?

Kenneth. If you do your best in every class, there wouldn't be time for anything else!

Mrs. McM. What about the films we have seen?

Wilma. The one on petroleum had too much advertising. The molecular motion film is pretty good.

Dorothy. If we didn't have to take notes on the movie, we'd get a lot more out of it.

Helen. I think it would be better to concentrate on the movie and then have a class discussion right afterward.

Kay. You will remember what is told you better if you know what to look for and then see the movie and then talk about it.

Kenneth. The one on Texas had too much about one state. I think if we are trying to learn about the whole world there isn't enough time to spend on just one state.

Philip. But this is the first year I have had any science and I think we should spend more time on the textbook.

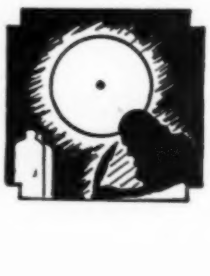
Dorothy. Magazines hold my interest more than the book because they are up to the minute.

In a final report the science teachers noted that effective use of current materials requires much care in selection by the teacher. But articles which class use shows to be helpful can be filed for future classes. The materials proved more of value for enrichment than motivation. To be effective, use must be specific; magazines and films must not be introduced to fill up time. Current materials develop interest and spur the teacher to better teaching. Bright students found magazines helpful for extra reports. But even those of low reading ability learned much from pictures, charts, and the like. Their interests began to unfold into larger areas. Scrapbooks developed initiative. They found they could succeed at something. They also had something to talk over with their parents at home.

A new spirit of cooperation between school and home grew out of this study. Parents found they had common ground on which to talk over affairs of the time with their children. One parent, a dentist previously critical of the school, offered a complete exhibit of dentures, tooth charts, and dental materials to supplement the class study of nutrition.

Finally the teachers recommended to themselves:

1. Periodically each should re-evaluate his teaching procedures.
2. Use of available current materials should be an integral part of teaching.
3. Use of magazines should be a part of every science course.
4. Long range planning is essential to incorporate magazines, films, bulletin boards, and project materials.
5. Be careful to see that students are allowed self-expression.
6. New instructional materials are not something to add to existing courses but to replace outmoded practices and materials. ●



Air Friction at High Speeds

Melting noses are accompanied by cooling tails in missiles flown at thousands of miles an hour at great altitudes according to calculations by Drs. Jackson R. Stalder and David Jukoff, research physicists at Moffet Field, California.

The high speed associated with flight at very high altitudes introduces many new problems to the aircraft designer. One of the more important problems is due to overheating of the aircraft or missile due to air friction. The severity of the problem is shown by the melting and combustion of meteorites that enter the earth's atmosphere at high speeds.

At the extreme altitude encountered during flight of sounding rockets or missiles, the atmosphere can no longer be considered as a continuous medium, and account must be taken of the motions of the molecules comprising the atmosphere.

Using the methods of kinetic theory, calculations have been made of the temperature of bodies traveling at high speed in the upper atmosphere. The calculations cover a range of altitudes of from 75 to 150 miles and a range of speeds up to 13,000 miles per hour.

It is shown that, under all flight conditions above 75 miles, to alleviate the frictional heating problem, body angles should be kept as small as possible. This implies the use of slender bodies with long, pointed nose sections. It is also shown that for negative body angles with respect to the flight path; i.e., on the boat-tailed section of the body, the skin temperatures are very much lower than on the nose section, and above a certain speed, the faster the missile is flown, the cooler the boat-tailed section becomes. This immediately suggests the use of an internal cooling system connecting the forward and rear portions of the body.

It is shown that at 75 miles altitude, the presence of solar radiation has little effect upon the body temperatures at the highest flight speed calculated. The effect of solar radiation would be expected to be more important at the lower flight speeds. On the other hand, at altitudes of 150 miles, solar radiation is the predominating factor that determines the body temperature, at all flight speeds.

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"Prejudice and facts confuse the thinking of many people. Very many intellectual people in fact, think science has gone so far that the entire human race is in danger of race suicide. Others think that science, unmindful of the effects of its work on society, should be curbed or limited by some form of legislative regulation. Have we reached a point where we cannot go further because we cannot trust ourselves?"

C. F. Kettering
Science

Gardens

(Continued from Page 46)

school garden program at all garden centers. Supervised work experience at jobs definitely within their capabilities, is a real need of city boys and girls. A large part of the routine garden work which would otherwise be mere labor for laborers, becomes an educative activity of marked value. Upwards of 50 boys and girls are hired as student assistants each season, working part time as the season demands.

Conclusion

This brief summary of a garden-science program which has long functioned to the advantage of all concerned, is given in the hope that it may encourage other school systems to experiment in the field.

It is hardly sensible to deny the value of gardening as an educative activity. That gardening is science, applied in every-day life patterns, is also beyond dispute. In content and in practice it has values for pupils, the school, and the community. Why, then, do so few school systems make any use of it?

The usual excuses are lack of funds, lack of personnel, lack of time in the curriculum. The first two are always remedied for any activity which is really felt important. The Cleveland solution to the third is indicated in this article. Gardens *are* science projects. ●

Variable Focus Condensers

You can now change microscope illumination for various objectives as conveniently as you set your watch.

Important . . . For, as you well know, it is often profitable to study an object under both low and high magnifications, necessitating one or more changes in objectives and cone of light.

When shifting from one objective to another it has been simply necessary to revolve the nosepiece until the wanted objective is positioned in the optical axis. However, up to now, in going from high to low magnifications, it has oftentimes been necessary to effect the required change in illumination by the devious process of racking down the condenser and removing the top element, then refocusing to secure the proper setting. This procedure took time, interrupted the inspection of the specimen, and resulted in a disappointing decrease in intensity of illumination at low powers.

Bausch & Lomb, by means of a patented Variable Focus Condenser now makes available to the microscope user modern instruments which permit practically instantaneous changes of magnification. The necessary coordinating of objective and condenser N.A.'s through focusing the substage condenser is quickly accomplished by the simple turning of a large, convenient, adjustment knob.

Observation of the specimen is not greatly interrupted, the technician need not remove his attention from the eyepiece, and the intensity of illumination does not suffer. Where the change may formerly have required a break of several minutes in the observation procedure, now only a few seconds, at the most, are required.

New York Subway Laboratory

The New York Subway has made a contribution to science by providing two Fordham University physicists with an escape from cosmic rays.

The story came out recently in a solemn, scholarly report on "Surplus Gamma Radiation from Rocks," by Victor Francis Hess and J. Donald Roll, S.J., at a recent meeting of the American Physical Society at Columbia University.

Studying the mysteries of radioactivity of certain types of granite the scientists wanted to be sure that cosmic rays which bombard the earth from outer space and produce radioactive effects, did not interfere with their results.

They found their escape in the Independent Subway, under Fort Tryon Park, where, under 160 feet of solid rock, "the most penetrating component of cosmic rays" was reduced to less than one tenth its strength.

Their conclusion was that potassium itself may be more radioactive than originally expected. Further experiments will tell whether this is so or whether the radioactivity is from some unknown source.

The laboratory—a small iron hut—was constructed by the Board of Transportation of the City of New York on the north end of the platform of the 190th Street station, Washington Heights, and the experiments took place between July 18 and August 30, 1947.

Sound Waves Can be Used to Measure Atmosphere Temperatures

Sound waves can be used to measure upper atmosphere temperatures according to Dr. Everett F. Cox, Naval Ordnance Laboratory, Washington, D.C.

Around a source of loud noise, such as the explosion of an ammunition dump, there are alternate rings of noise and silence. No noise may be heard at one place and a few miles further away windows may be shattered by sound waves. This condition is caused by layers of hot air in the upper atmosphere which serve as reflectors.

The first layer of air above the earth, extending 8 to 20 miles, averages about 75 degrees F. below zero. The next, containing a high proportion of ozone which absorbs ultraviolet rays from sunlight which heats it, averages about 100 degrees above zero. Beyond this is another layer of colder air, and still higher the temperature again rises.

"Since sound waves are bent back to the earth by the hot layers of the upper atmosphere, measurements of sounds received at great distances from explosions can be used to calculate temperatures of the earth's outer air layers," he said.

The research is important particularly in solving problems of supersonic flight.

Observations made by Naval Ordnance Laboratory scientists in connection with the demolition of German fortifications at Helgoland in April, 1947, where 5,000 tons of TNT were exploded, showed that subsonic waves carried to Gorizia, Italy, 620 miles away.

Temperature values calculated from these records, Dr. Cox said, show an ozonosphere peak of 70 degrees F. at 35 miles altitude, a dip to minus 150 degrees at 45 miles, then a temperature rise to 260 degrees at 100 miles above the earth.

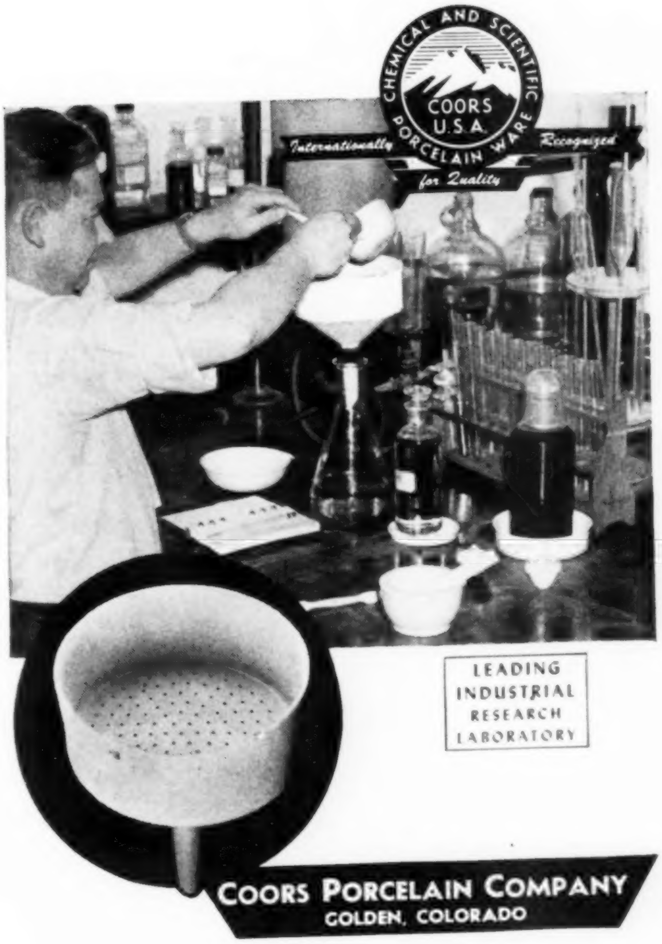
Petroleum

(Continued from Page 49)

shales are in the Rocky Mountain area, somewhat inaccessible to the industrial East. An item in favor of processes based on coal and oil shale is that both raw materials are available in quantities enormous in comparison with the reserves of oil and gas; the coal supply, for instance, is estimated to be good for three thousand years at present consumption rates.

Of one thing we can be fairly sure: disregarding temporary price fluctuations caused by inflations and depressions, the cost of our fuels is likely to rise. We have so far been skimming the cream of our fuel resources; the use of what remains will demand more in terms of capital investment and human labor.

The setting of a wise national policy for intelligent and conservative use of our fuel resources is complicated and difficult. One safe conclusion, however, is easy to reach: we must investigate thoroughly all the possible alternatives. The most expensive research will cost only a trifle compared with the investments we have already made and must later make to keep our national economy going. The difficulties ahead will contribute that element of conflict which contributes so much to the spice of life. ●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